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REGENERATION IN MAN

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BY

M. A. ANSARI

WITH FOREWORD BY

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To the memory of
my parents and my brothers.

FOREWORD

The desire of man advancing in years to obtain youth and prolong life is a yearning that has moved mankind for centuries. For a long time men have tried by different means to control the changes which, caused by age, destroy the human organism. All these efforts, however, have proved of no value, and in their effect they have been such as can be attributed only to suggestion. The exact experimental researches of the last few decades, which especially ascertained the importance of the endocrinal glandular system for the course of vital processes, have provided the foundation on which scientific methods of treating the alterations in the aged organism have been based. The scientific bases for these new ways of medicine were the experiments conducted by Professor Steinach on animals, which proved in a clear and undoubted manner the significance of the endocrinal activity of the sex-glands in the course of these important life-processes.

The author has verified on a large material of patients examined with extraordinary accuracy the results of experiments relating to

vaso-ligature and the transplantation of the sex glands. His successes, extending to some hundreds of observed cases with different alterations on the aged organism, are very satisfying and one is specially impressed by the exact clinical observations of these cases and his very critical judgment. This work will give very valuable and instructive information to anybody who studies the subject.

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XIX, Peter Jordanstrasse 82,
Wien. June, 1934.

CONTENTS

INTRODUCTION

It may be helpful to the reader to know at the outset the precise meaning and significance of the title I have selected for this book ; the exact sense in which the word "regeneration" is used in this work and the reason why it is chosen in preference to "rejuvenation" or "reactivation". The term "regeneration" is derived from "generation", which signifies "begetting, originating, bringing to life", the prefix "re-" meaning anew or again. In connection with plant or animal life, it is used in the sense of production or procreation. The word "regeneration", therefore, means to acquire new life, new energy, and new vigour. Because of its association with moral and spiritual renaissance, it is preferred to the word "rejuvenation", which stresses the physical and sexual aspect of regeneration. The word "reactivation" would have fulfilled the purpose admirably, but it is rather technical and perhaps will not appeal to the general public so much as the word "regeneration".

The desire for regenerative methods of treatment is wide-spread in India, where cases of

premature senility in both sexes and in all strata of society are commoner compared to other countries. Its causes are many,—tropical climate, unhygienic surroundings, low standard of living due to poverty, poor general physique, adverse social conditions, segregation of the sexes, early marriages, high birth-rate, lack of medical and sanitary aid and low average of life. It is not unusual to see women at 25 and men at 35 beginning to show clear decline and decay in their mental and physical powers and to become prematurely senile, although this period is generally regarded as that of healthy and vigorous youth. These pre-seniles, who are subject to easy fatigue, disinclination to work, failing memory and mental depression, find their condition a handicap in the struggle for existence and a great hindrance to progress; they furnish a larger quota of persons seeking medical relief than those who are actually senile and who, being generally advanced in age, give up fighting against their infirmities.

Incidence of Premature Senility in India

In my own experience, the great majority of patients who visited my consulting rooms for other conditions, would invariably point to their failing strength and vigour, to the thinning of

the semen—"spermatorrhœa" as they called it —to failure in potency, besides the more obvious and urgent complaints for which they had come. I was thus led to the study of premature and physiological senility early in my professional career, as I had to deal with a considerable number of patients suffering from real or imaginary decline in their mental, physical and sexual powers.

I used to treat my patients by the usual drugs, including extract of dried sex-glands, with indifferent results. In 1915 I came across the reports of Brown-Sequard's experiments and Bouin and Ancel's researches, which gave me a real insight into the subject. Since then I started administering fresh extract of raw testes to patients, which yielded infinitely better results than other drugs, including extracts prepared from dried glands administered by mouth or by injection. Later, I read an illuminating article on the subject by Sand, of Copenhagen, in the Journal of Physiology, for December, 1919, which impressed me deeply and acted as an incentive to further investigation into this particular field of medical research.

I visited Europe in 1921, when a great controversy was going on in the British press owing to the sudden death of Mr. Wilson on the eve

of his much advertised lecture at the Albert Hall, on the subject, "How I Became Young". He was over 70 years of age and, besides senility, had suffered from steno-cardia. The operation of vaso-ligature and vasectomy by Steinach's method had produced very fine results, but in spite of warning, he was extravagant in the use of his newly acquired powers and died of heart failure after a drinking bout. His death produced a very bad impression. There were articles in the medical and lay press against Steinach's method of regeneration. It had, however, the effect of bringing the subject to the fore in the minds of the public and of scientific men. I studied all the available literature on the subject. Unfortunately there was very little written in England, though a considerable amount in France, Switzerland, Germany, Austria and America. My ignorance of the German language placed an almost insuperable barrier in the way of my studies in this branch of medicine. I had to spend a good deal of time in getting the original German papers translated into English, but fortunately translations of some of these papers, found in French and American scientific literature, helped me to study them.

My first visit to Vienna in the Autumn of

1921 was an event not easily forgettable. The innate courtesy of Viennese men of science was obvious everywhere I went. Professor Eugene Steinach met me himself at his biological laboratories in the Vivarium in Prater Park, along with his wife who acted as interpreter. The animals (rats and guinea-pigs), on which he had conducted his classical experiments, were carefully dissected and displayed in glass jars, preserved in spirit. In the castrated male and the spayed female, the atrophy of the organs of generation, the shrinkage of the skeleton and muscles of the body, the falling away of the hair and thinning of the coat, were shown clearly. Then the castrated male in which a testicle had been grafted, and the spayed female in which an ovary had been implanted, showing beautiful coats, enlarged skeleton and muscles, and normal organs of generation (prostate and vesicula seminales in male; uterus and mammæ in the female), were exhibited. The masculinised female and the feminised male animal with its well-developed mammæ and feminine instincts marked to the extent of its actually suckling the litter born of another animal, were convincing proofs of the effects of hormones from the sex

Visit to Vienna—Steinach's Laboratories.

glands on secondary sexual characters and sex instincts of the animals experimented upon. There were also the different hermaphrodites and the homosexual animals produced artificially and, finally, the regenerated senile rat, placed beside another animal of the same litter by way of contrast.

In an adjacent long and lofty room were kept live animals in their cages. There were several litters of newly born rats; there were animals operated upon that day; there were others operated upon, one, two or three days before, showing different grades of change; there were young, playful and vigorous animals; there were old ones, indolent, apathetic, with scraggy coats, falling generally into decay, and lastly, there were those restored to youth after operation.

My subsequent visit to the clinic of Primarius Dr. Robert Lichtenstern, in the Spital der Kaufmannschaft, seeing his cases and discussing them with him, showed that the application to man of Steinach's experimental researches had produced outstanding results in different conditions for which it was used. Lichtenstern, who has complete command of the English language, spoke on the basis of extensive clinical experience. His observations were profound and

convincing.

On my return to India, I read a paper in November, 1921, before the Delhi Medical Association, on the "Arrest of Senescence and Possibilities of Regeneration, with special reference to Steinach's experiments and Lichtenstern's application of these results to Man". Between 1922 and 1924, I studied a good deal more and generally kept in touch with the work done in America, England and on the continent of Europe; but at that time I was able to do very few operations of vaso-ligature and vasectomy, or grafting of sex-glands. The cases, twelve in all, that I had treated could not all be followed up and, with the exception of five, were lost sight of. My results were also not encouraging owing to inexperience and faulty technique.

My early experiments.

During a subsequent visit to Europe in the summer of 1925, I made a round of the hospitals and clinics where work on this branch of medicine was being done and watched with care the technique of different workers and discussed their results with them. I visited Paris, Lucerne and Vienna specially, and saw the work of Voronoff, Stocker, Lichtenstern and Steinach. I gained much in practical and clinical know-

ledge in this tour and determined to pursue the work vigorously.

I read a second paper on the basis of my investigations in Europe, and my own limited experience, in October 1925, before the Delhi Medical Association. It was entitled, "Recent Researches on the Regenerating Effects of Internal Secretion of the Sex-glands, with report on five cases, two of Steinach's operation and three of testicular grafting".

From 1926 to the present time, I have been fortunate in maintaining continued interest in this branch of medical work and have operated on more than six hundred patients. I have endeavoured to keep in touch with these patients directly or through their attending physicians over a period of three to four years. My efforts in this direction have been rewarded in that I have been able to keep records of 440 cases of different varieties of operative methods undertaken for bringing about regeneration.

This work would never have been undertaken had I not visited Vienna in the autumn of 1932 and talked to Professor Steinach of the clinical material at my disposal. He told me that workers in this field of research had contributed from every country except India and that I must fill the gap. He thought well of my

work, and pressed me to publish it. Primarius Lichtenstern was also very encouraging, and promised to write the foreword to my book.

I commenced writing in the autumn of 1932. My object was to write as short and concise a book as the subject would permit, and not an exhaustive treatise. In reviewing the experimental and clinical work, I have covered the entire field up to date. I have not omitted any important or outstanding contribution. I have, however, not given an exhaustive bibliography on the subject, but confined myself to a list of publications actually used in preparing this work.

I am deeply indebted to my old friend Dr. Saiduzzafar Khan and to Prof. M. Habib for their criticism and valuable suggestions regarding the subject-matter and the arrangement of this book. I am also indebted to my young friends Doctor Muzaffar Ali and Mr. Murtuza Khan, students of medicine at the University of Vienna, but for whose arduous labour in translating many of the German monographs, I would not have been able to avail myself of them. I am deeply grateful to Prof. M. Mujib of the Jamia Millia Islamia, Delhi, for the infinite pain and care with which he has corrected the proofs of the book. Lastly, if it were not

for the continued help, guidance and moral support of my friend Mrs. J. F. Kelley, this work would never have seen the light.

M. A. Ansari

Dar-es-Salam,
Delhi
October, 1934

CHAPTER I

HISTORICAL

Before presenting the modern scientific ideas and conclusions concerning the subject of regeneration, it would not be out of place to give a brief consideration to its history.

The attention of the ancient sages and thinkers of Asia, Egypt, and Europe had been directed from time immemorial to the mystery of generation and reproduction. Finding that life was concentrated in the tiny seed of a plant or an animal, they regarded such vital force with religious awe and considered it to be supernatural. Their observations on the effects of sexual mutilation on animals and men and of the changes brought about in the mind and the body by the quickening of reproductive powers at puberty and adolescence, and by their decrease in old age, led these ancient thinkers to the conclusion that the generative forces, if properly controlled and directed, were capable of continuing the vigour and vital strength of the individual almost indefinitely.

Raja Yoga Philosophy.

In the ancient Yoga philosophy of the Hindus, long before the Christian era, it was taught as part of "Raja Yoga" that by practising chastity in thought, word and action, the generative powers, "Ojas", could be directed into certain physical and psychical channels, not only to increase physical strength, energy and vigour, but also to cultivate great mental powers and psychic qualities. This essential idea of Hindu philosophy permeates Hindu religion, though in many cases it has become corrupted by loss of the original spirit and has developed into fanatical asceticism and degradation of the idea of sex and reproduction. Regeneration was upheld not because generation was wrong, but because its control gave additional power to the vital forces present in man's system.

Buddhist Theory.

The ancient Buddhists held that the "will-to-live" was the cause of creation; that in its most potent form it existed in sexual energy and that the latter might be controlled and employed not only in generation but also in regeneration. They held that in some cases this creative energy would carry the individual beyond the necessity of physical life in reincar-

nated forms, delivering him from "Dharma Chakra" (the "Wheel of Life") and thereby enabling him to attain "Nirvana".

Isis Cult.

The ancient Egyptians taught a similar doctrine in the secret Isis cult. Their teaching was withheld from the common people and reserved for the elect. The creative principle was conceived as feminine; if carefully conserved and not wasted in generation, it might be transmuted by the process of regeneration into superhuman and possibly supernatural psychical and spiritual powers. In certain cases it was held that mortal man might be transformed into a god by the efficient employment of the power of regeneration.

Jewish Beliefs.

The ancient Jews held similar beliefs; references to these are found in occult Hebrew writings. They taught that the story of Adam and Eve was merely an allegorical representation of the same principle. The male and female human beings were destined to live for ever, their creative energy being turned inwards in the process of regeneration; but, being tempted by the "Evil Spirit" and turning their creative energy into channels of generation, Adam and Eve perpetuated the race as a whole but

brought death to its individual members.

The alchemists and occult philosophers in the middle ages devoted much attention to the subject of regeneration. Their "Elixir of Life", which conferred on man the power to live far beyond the allotted span of life in possession of his full vigour and vital energy to the last, was not a cordial possessing these wonderful properties, but the conserved creative energy of man, transmuted into inner vitality instead of being expended in the function of generation.

Alchemists and Occult Philosophers.

Thus the idea of regeneration, the turning of the creative energy inward rather than outward, creation on the mental, psychical, and spiritual planes rather than the physical and material planes, is at least several thousand years old, if not as old as mankind.

So long as the human race has existed, it has looked with considerable aversion and fear at the steady decline of faculties and decay of powers caused by old age, leading ultimately to death. Man has ever been busy in endeavouring to devise measures in order to delay the onset of decline and decay and, if possible, to encompass their defeat. Various measures and

Fear of Old Age.

devices for the prevention of old age existed in ancient India and China. In recent times, the Ayurvedic and the Unani, the two ancient systems of medicine in vogue in India, possess innumerable prescriptions for regeneration and rejuvenation. The great majority of the recipes have testes or other glands and organs of animals as the chief ingredients. In India and the East, there has existed some knowledge regarding organotherapy and especially of the fact that the testicles contained substances which have powerful effect on processes leading to senescence. This, therefore, is not a path of research along which we have pursued an entirely fresh track.

Castration an Age-old Practice

Castration in animals and men has been in vogue for ages, its effects on fecundation, general physique and the configuration of the body, and the alterations caused by it in the characteristics of different animals, have been widely noted and well-known for a long time. The castration of cocks to make them fat and more edible as capons, of bulls to render them docile and tame and of stallions to make them less spirited and more easily manageable, has been practised for ages. The practice of castration in order to prevent

the breaking of voices in young choir boys was common in the middle ages and the general effects of castration on mental, physical, and sexual powers of eunuchs have been observed and studied for centuries; but the real scientific basis of this relationship was not understood until Brown-Sequard conducted his researches.

CHAPTER II

STUDY OF REGENERATION FROM SIMPLE CELLS TO HIGHER ORGANISMS

In examining the phenomena of senility and regeneration from a general point of view and in the light of the experimental investigations of recent years, we ought to consider not merely man and the higher animals but, so far as possible, the whole living world. Our conceptions of the phenomenon of age should be formulated on the basis of what we find in the simpler organisms, as well as in the higher forms and in man. If, as we believe, evolution has taken place, all that we can learn about the simpler forms of life should assist us in investigating the higher and more complex forms.

Multiplication of Protozoa.

In the protozoa and some other low forms of animal life, multiplication by binary fission occurs indefinitely, so that one organism is succeeded by two, and as there is no vestige of a corpse, to quote Weissmann, "the organism is immortal". According to

Maupas,[1] without occasional conjugation of two individual protozoa and the resulting regeneration, the organisms become senile and die. But Woodruff,[2] having isolated a single infusorium cell, was able to follow its reproduction during thirteen years and count eight thousand and four hundred generations without noticing any retardation in the continuous sub-division of the cells. It, therefore, seems not improbable that endomixis provides the regeneration otherwise resulting from conjugation. C. M. Child[3] shows that, in certain circumstances, senility occurs in the protozoa as in the higher animals, but that death is avoided by regeneration in each process of reproduction by fission; reconstitution occurs in this manner and new organs are formed in place of the old ones lost or damaged.

Reproduction in Higher Forms.

With the passage of time, and modifications in conditions of existence, certain cells grouped themselves to form individuals with organs better adapted to new needs of the aggregate or the colony; but this grouping did not affect the essential nature of

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1. Maupas, *Arch. de Zool. exper., 1899.*
2. L. L. Woodruff, *Proc. Nat. Acad. Sc.*, Washington D. C. 1921.
3. C. M. Child, *The Harvey Lectures, "Senescence and Rejuvenescence from the Biological Standpoint"*, University of Chicago, 1915.

the primary cells, since each cell was both somatic and sexual in nature. Indeed, many of the lower metazoa retain the faculty of completely reproducing themselves from any part of their body. Such are the coral cells which propagate indefinitely to form reefs extending over hundreds of miles. Fresh-water hydrae possess the same faculty of regeneration; even when cut into very small fragments, each fragment can reproduce a complete hydra. Other animals higher in the scale of life, such as the fresh-water planarians, are able to reconstitute a complete individual from any fragment of their body.[1] Even the earthworm, 'lumbricus', endowed with a highly developed structure, a complex alimentary canal, a vascular system, and organs of sense, has preserved this faculty, each fragment of the body being able to regenerate into a complete individual. It has, therefore, to be admitted that these cells, in spite of their differentiation and highly specialised character, are still able to revert to the embryonic state in order to regenerate a complete individual from each fragment of the body.

By tracing the evolution of life to its more highly perfected manifestations in the animal scale, we find that the somatic cells lose this

1. C. M. Child. *Harvey Lectures*, Chicago, 1915.

Why are the Vertebrates Mortal?

faculty of regenerating the complete organism. At first the power of regeneration becomes limited to the reproduction of the organ of which the animal has been deprived. Insects and lobsters possess the ability to grow lost limbs or claws, but are unable to reproduce a complete new individual. Among lower vertebrates, the amphibians still enjoy to a slight degree this property, and the lizard is able to restore its tail, though imperfectly. The higher vertebrates— birds, mammals, and man—are totally deprived of the means of renewing a part of the body.

The explanation of this phenomenon is to be found in the state of development of the higher organisms. The primitive form, consisting of one individual cell endowed with power of infinite multiplication and growth, was followed by an aggregate of several cells still sufficiently simple to retain similar powers. They were followed by more highly differentiated varieties gifted with organs designed to fulfil special functions, and for this reason made up of cells greatly varying from the primitive type; the appearance of the various cells which make up our body is, therefore, different from that of the primary cell. These highly developed cells have

been able to retain the faculty of reproducing themselves by mitosis, but have lost the power of returning to the embryonic state and thereby of rebuilding the complete individual. But to ensure the continuity of the species, it was essential that certain cells should become specialised; hence the corporeal or somatic cells participate only in ensuring the continuity of life of the individual, and the sexual cells are designed to perpetuate the species. The somatic cells are mortal, but the sexual cells retain the faculty of reproducing a complete individual, and remain immortal, thus eternally ensuring the continuity of life.

Growth and Life-Cycle can be Controlled.

Modern biologists have shown that the life cycle and growth which are closely co-related, may be modified by various methods. Planarian flatworms become smaller by starvation and their life cycle is reversed by the process called de-differentiation or involution, whereby their structure becomes simpler. By alternate feeding and starvation, Child has kept them at the same size while controls passed through nineteen generations, thus showing that the life of cells is not a matter of time but of metabolism.[1] Julian S.

1. C. M. Child. *Harvey Lectures*, Chicago, 1915.

Huxley,[1] produced similar retrogressive changes in the ascidians (Clavellina and Perophora) by this process, which seems to be the primitive reaction to unfavourable circumstances.

In the higher animals more complex conditions are found, due to the self-regulating mechanism, especially of the ductless glands; but by experimentally disturbing the endocrine balance, some remarkable results have been obtained. Robertson and Ray, by feeding white mice on tethelin, a phospholipin obtained from the anterior lobe of the pituitary, found retardation of the increase of weight, but prolongation of the duration of the life of the animal.[2] They also found acceleration in epithelial proliferation. Gowland Hopkins[3] first proved retardation of growth due to a diet deficient in vitamins. Steinach rejuvenated senile rats by ligature or section of the vas deferens, followed by increase in the interstitial cells of the testis and definite prolongation of life.[4]

Though every living species of animal may, in normal circumstances, have its allotted span of

1. J. S. Huxley. *Journ Microscop. Sc., 1921, LXV, 643.*
2. T. B. Robertson and L. A. Ray. *Journ. Chem. Biol., 1919, XXXVII, 455.*
3. E. G. Hopkins. *Journ. Physiol.*, Cambridge, *1912, XLIV, 425.*
4. E. Steinach. *Verjuengung durch experimentelle Neubelebung der alternden Pubertaetsdrusen.* J. Springer, Berlin, 1920.

life, it is so much subject to modifications by external factors that the average duration of life, especially in long-lived species, does not extend to the natural period of years. Sudden death by trauma or infection is so much the rule that even the occurrence of natural or physiological death has been questioned by some scientists. Metchnikoff, who paid special attention to this question, thought death was mainly due to intestinal and other infections.[1] While it has to be admitted that this still holds good, our efforts in future should be to make it no longer true.

Death of Tissues and Old Age.

This leads us to the consideration of the processes which bring about old age and death of tissues. To explain the retrogressive processes normal in old age, it has been assumed that the body cells are endowed with a certain store of vitality and that as this becomes exhausted, the process of involution begins. The process of ageing of the cells is thus regarded just as much a part of their development or life cycle as their earlier progressive stages. The reproductive cell, when it meets with its complement and starts a fresh lease of life, is an exception. To quote Sir E. A. S. Schafer, "We can only be immortal through

1. Metchnikoff. *The Nature of Man. English Translation, 1903.*

our descendants".[1]

That there is a definite cycle during which the cells multiply and after which they cease to do so, is supported by the study of anatomical and physiological changes in old age. The atrophy of the organs is due to diminution of the specialised functional cells of each organ, and hypertrophy and increase of the connective tissue cells, and, later, of the fibrous tissue cells. Thus, the ovary undergoes fibretic atrophy and ceases to be actively functional after the menopause. This is also well illustrated in the spleen and in the lymphatic glands, which are very active in youth and become atrophied in advanced life. This diminution in the function of each organ results in the general weakening of the body, and eventual death.

Explanation of Decay.

How is this gradual decrease of the specialised functional cells brought about, and how does increase in connective tissue cells take place? Bechhold[2] has shown that, like a simple colloidal jelly, the cells of the human body, which are colloidal masses, lose their affinity for water progressively with

1. E. A. S. Schafer. *Presidential Address, Brit. Assoc., 1912.*
2. H. Bechhold *Die Kolloids in Biologie und Medizin* Dresden, 1921.

age, and become less elastic. Ruzicka[1] also found that in senile persons, hysteresis or drying up of the protoplasm of the cells takes place. According to Marinesco,[2] dehydration of the colloids in the cells was an inherent change in evolution and led to senescence and death.

Another reason for loss of cell vitality has been discovered by Lumiére,[3] who thought that as the result of metabolism, the cell protoplasm became overladen with products of the cell activity which were inimical to its vitality, and which, in their turn, hindered cell metabolism. The aggregations of albumen, constituting the colloids of the cells, alter in their structure and become more and more stable, until the colloid state disappears altogether and the cell, inevitably, dies.

Life-cycle Determined by Interaction of Tissue and Plasma.

It also appears that the life-cycle of the cell is determined not so much by time, as by the interaction of the tissues and the plasma. Carrel showed by cultivating connec-

1. Ruzicka. *Ueber Protoplasmahysteresis und eine Methode zur direkten Bestimmung derselben.* Pflugers Archiv., Bd. 194, Heft 1/2.
2. Marinesco, *Etude histologique sur le Mecanisme de la Senilite, 1904.* Also *Presse Med., Paris, 1922, XXX, 309.*
3. A. Lumiére. *Rôle des Colloides chez les Etres vivants,* Paris, 1921.

tive tissue in the plasma of chickens of different ages that its growth was more vigorous in the plasma of younger animals than in those of older ones.[1] Leob and Northrop,[2] working on the same lines, came to the conclusion that the duration of life was determined either by a substance leading to old age, or by the destruction of a substance, which normally prevents old age and natural death. More recent researches of Carrel and Ebeling[3] have led them to conclude that, in the cultures of connective tissue, the rate of multiplication of fibroblasts and the duration of life in vitro, varied in inverse ratio to the age of the animal from which the plasma was taken, and that this depended on the presence of an inhibitory body in the plasma of the older animals. Carrel and his co-workers have shown that, with frequent washings to remove waste products, tissue cells can be cultivated indefinitely for years, and have an unlimited capacity for multiplication. The ageing of the cells in the living organism, therefore, appears to be determined by extrinsic factors found in the plasma rather than by any inherent limitation in the cells. In

1. A. Carrel *Journ. Experim. Med.*, Baltimore, 1913.
2. Leob and Northrop. *Journ. Biol. Chem.*, *1917*.
3. A. Carrel and A. H. Ebeling. *Journ. Exper. Med.*, Baltimore, 1921.

the ordinary conditions of life, senility of the cells might be regarded as the result of increased differentiation and of diminished metabolic activity, possibly due to accumulation of material which cannot be utilised for regeneration as in the embryonic cells. As atrophy of the functional cells and increase of connective tissue are regarded as characteristic of old age, Robertson and Ray[1] have suggested that the potential longevity of any individual is determined by the relative velocities of anabolism in the cells on the one hand and in the fibrous tissue on the other hand. A low rate of cellular anabolism increases the growth of the cells and delays the increase of the fibrous tissue. It can be said in general that the cells of complex organisms depend for their duration of life not so much on an inborn store of vitality as on metabolic changes in the protoplasm, which in their turn are controlled and modified by extrinsic factors of different kinds.

Senescence and Endocrine Glands.

In order to recognise the processes leading to old age and the course of senescence, we have had to delve into the intimate nature of our tissues. Similarly, it is by studying the functional processes of our organism that we

1. T. B. Robertson and L. A. Ray. *Journ. Biol. Chem.. 1920, CLII, 21.*

can hope to discover what can, at the time of advancing age, stimulate the vitality, energy and proliferation of the functional cells. This study has revealed that, outside the organs which preside over the intellectual, digestive, circulatory, and respiratory functions, there are other organs which act upon them from a distance, by means of substances which they pour into the circulatory system. In this way they are able to influence the far-lying territories of the body, and even the whole organism. These are the endocrine glands, which by means of their internal secretions called hormones, act upon the nutritional exchanges and on the morphology and evolution of the cells. The relation between these endocrine glands and senescence demands some discussion.

If one of these glands had been made to elaborate some substance, which acted as a tonic and stimulated the vitality of the cells of the body, its function would be limited to a certain period of life, and would cease with the advance of old age. If, for example, it was the thyroid gland, men of advancing age would become myxoedematous and idiotic. If the parathyroid had ceased to function in the senile, death would follow from tetanic convulsion. If the suprarenal glands suspended their function, men at a

certain age would become bronzed and die of Addison's disease. But the functions of all these glands continue during advancing age, though doubtlessly weakened. One gland alone forms an exception to this rule, *i.e.*, the genital gland.

While having no notable effects before the advent of puberty, the genital glands manifest a great activity during youth and adult life, an activity which is most marked when the organism attains to its greatest strength and its greatest energy. Later on, the glandular activity diminishes, eventually to end completely. The decrease of this activity, and ultimately its complete abolition, corresponds with old age.

Man is as Old as his Sexual Glands.

As sexual activity is the biological reason for existence, and as in vigorous men sexual power may last long beyond the usual period, a man may be said to be as old as his sexual glands. It is widely believed that the functional activity of the sex glands is a cause, rather than an effect, of the preservation of the bodily vigour, and conversely, that failure and atrophy of the sexual glands cause old age and senility. This belief appears to be formed on something more than a coincidence, and the relation of cause and effect may well be invoked in this case.

Let us examine the role of the male sexual

glands. The part played by these organs can be best appreciated by the study of the disorders brought about by their suppression. If vitality were not lessened by castration, and if the effects of castration did not, in the main, correspond with those witnessed during old age, then our presumption would be wrong and should be given up. If, however, the reverse takes place, the relation of cause and effect will have been experimentally demonstrated. Castration has been practised on a large scale on domestic animals and even on men in certain ages and in certain countries. It has been also performed in the laboratories by scientists for the methodical study of its effects on the sex organs. A great deal of material collected on this subject has plainly revealed the profound influence of the internal secretion of the testes on the whole organism. This influence is not restricted to the secondary sexual characters—the crest of male birds, the horns of the bull, the beard in men—but affects the growth and transformation of the whole body, the hormone acting equally on the brain cells as on those forming the epidermis, the bones, or any other tissue.

Sex-suppression in Man—Its Consequences.

A few instances may prove helpful. In the castrated cock, the crest shrivels and the bird

ceases to crow, but also as a result of castration, the cock becomes indolent and fat, loses its courage, and its instinct of dominating and protecting the hens. The castrated bull can only develop thin horns; it also loses its ferocity, its provocative character, and becomes tame and docile. The impetuous stallion, so difficult to handle, becomes peaceful after castration and loses at the same time a great deal of its intelligence and muscular power. Hunting dogs after castration lose their fine sense of smell as also other qualities, and can never equal normal dogs. Men castrated at an early age have an inferior intelligence compared to the average normal man; they have weak memory, and are lazy and unresponsive. Men castrated late in life retain faculties they had acquired previously, but these faculties do not last long ; five or six years after castration they begin to suffer from marked lapses of memory, and find difficulty in concentrating their thoughts and in pursuing intellectual work for any length of time.

Testicular Hormone, Influence on Skeleton and Muscles.

The influence of testicular hormone on the skeleton is great. Its absence causes the ossification of the epiphysical cartileges of the long bones, especially of the tibia and the femur, to take place later than it should.

Animals and men castrated before the end of the period of growth become taller than the average. But the effects are not restricted to the elongation of the bones of the limbs; the whole skeleton is modified, the cranium becomes smaller, and the face narrower; all the bones of the body are lighter and thinner in castrates.

The hormone also generally affects the metabolism of the body. The alteration in the organic exchanges in the castrates leads to invasion of the body by fat The muscles of normal animals, especially those of the neck, are better developed than in those who have been castrated; the flesh of he-goats and rams is dark red and hard, with short muscle fibres, whereas that of the castrated animals is bright and red with fine, long fibres. The glycogen concentration of normal animals is superior to that of the castrated, and, therefore, the former have greater energy in their muscles

In eunuchs, decrease in the development of body-muscles coincides with the increase of fat all over the body and especially in the mammary regions, over the abdomen and the buttocks The skin is in no way less influenced; the hide of the stallion, of the bull and the ram is thicker than that of castrated animals. Similarly, eunuchs are pale, have dried, pigmented

and wrinkled skins, and their hair becomes white at an early age.

Longevity and Sex-gland Secretion.

As we have seen, no organ can retain its vital energy and function to its full capacity if the cells composing it are not stimulated and activated by the testicular hormone. The relation of cause and effect between the cessation of the secretion of the sex-gland and senescence is, therefore, not a matter of doubt. We have reason to suppose that if the genital gland were to remain active during advancing age and continued to pour its hormone into the circulation, the advent of senility would be retarded. A great number of the functional cells in our body remain active up to extreme old age; and if it were possible for them to receive the tonic effect of the sexual gland secretions, which would stimulate their weakened but not yet abolished potentialities, our bodies would remain young much longer; for, these cells would then be able to function and to multiply and to replace cells that are worn out.

If the effects of the hormone produced by sexual glands are constant, then there should be a definite relationship between the functioning of these glands and longevity; and normal animals and men should live longer than those that

have been castrated or have lost their sex-glands. Further, as a corollary, it should be possible to regenerate ageing animals and to prolong their lives by throwing into their circulation hormones produced by the sex-glands by one of the various methods devised for this purpose. This hypothesis has been confirmed by various horse breeders and veterinary surgeons, who assert that stallions reach an advanced age and geldings die much younger. Eugene Steinach found that by vaso-ligation or vasectomy in senile rats, he not only rejuvenated them, but that their lives were prolonged by 25 per cent. compared to other rats of the same litter.

Observation on eunuchs has helped us to appreciate the influence of testicular hormone on longevity. A careful study of their life-history has established the fact that they become prematurely old and die long before the age reached by the average normal man. It is easy to understand that a person deprived of an organ, the absence of which has rendered the bones brittle, the muscles weak, the fat abundant, and the nutritional exchanges sluggish will be subject to general weakening. We should expect such a person to become more vulnerable and less ready to fight the causes which destroy life long before the advent of

physiological death.

It can, therefore, be stated with certainty that the absence of the internal secretion of the sex-glands accelerates the onset of old age and shortens life. To retain the functions of the sex glands as long as possible and to have their internal secretion stimulate vitality, reactivate the organism, and prevent it from weakening, is to fight against old age and to delay the end.

CHAPTER III

REGENERATION EXPERIMENTS ON ANIMALS

Although in a vague and general manner the relation of sex-glands to sex and general characteristics in animals and man has been recognised for ages, the scientific study of the subject began only a little over a hundred and fifty years back. John Hunter, in 1770, successfully transplanted testicle in a dog, but the significance of the experiment was not understood. In 1849, Berthold, a German investigator, removed the testicles of a cock from their normal position, transplanted them beneath the skin of the abdominal wall, and found that the bird, instead of becoming a capon, retained all the characteristics of a cock. Important though the observation was, it was ignored at the time and no further development occurred in this field. During the second half of the nineteenth century, the inner secretion of the ductless glands was discovered by Claude Bernard.

The first person to apply the knowledge of the regenerating effect of the internal secretion

of the testes on human organism was the great French scientist, Charles Brown-Sequard. At the time he conducted these experiments he was himself over seventy years of age. He had been experimenting on himself and other ageing men in the hope of discovering ways of influencing the processes that manifest themselves in senility. He prepared fresh extracts from the testicles of dogs and injected these into his patients and into himself. He noted a remarkable increase in the functional capacity of the voluntary and involuntary muscles, the brain, and the reproductive organs. He registered all his observations carefully, both objective and subjective, and called them "Rejeunissements". When, in 1889, he reported to the Paris Academy of Science, he was laughed out in scorn.[1] Later on, however, when he published his findings, they created a sensation and there was such a rush of people desirous of being rejuvenated that his house in Paris was practically besieged and he had to seek refuge by running away to London.

Brown-Sequard's First Experiments.

The idea of Brown-Sequard, that regenera-

1. C. Brown-Sequard *Archives de Physiologie normale et pathologique* and *Comptes rendues de la Soc. Biol. de France, 1889.*

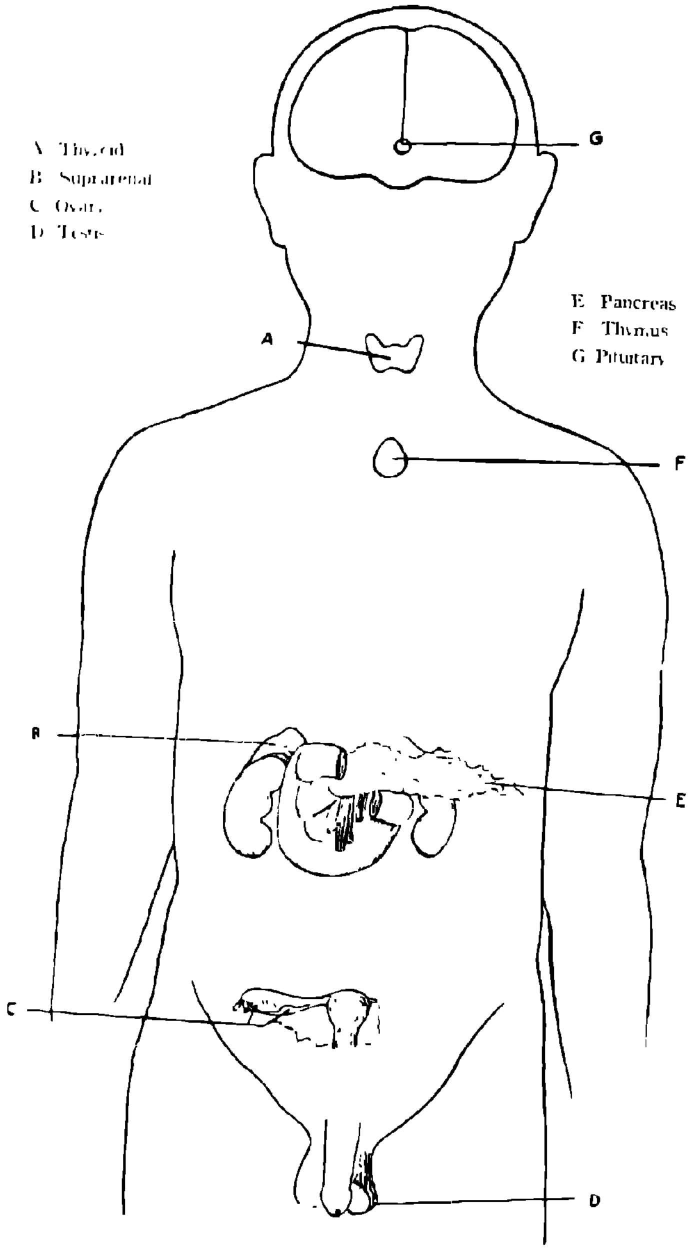
tion could be obtained in old persons by injections of animal testicular extracts, was justified, as the hormone secreted by these glands is the same chemically in animals as in man; the only variable factor is the quality and the degree of evolution of the functional cells acted upon by this hormone. The hormone produced by the human testis acting upon a horse would activate the functions of the brain of the animal according to its aptitude, just as the testicular hormone of a horse would manifest its action on the human cerebral cells according to their capacity. The science of organotherapy, which has undergone marked development during recent years, is based on this law formulated by Brown-Sequard.

Brown-Sequard's Law.

The therapeutic method of introducing into the organism the products of the internal secretion of the testes was, nevertheless, the cause of bad results and many failures The liquid obtained by tituration of this organ does not contain all the active elements It can even then produce some results if the preparation, as practised by Brown-Sequard, is injected immediately after it has been

Failure of Therapeutic Methods

SCHEMATIC DRAWING SHOWING MAIN ENDOCRINE GLANDS IN MAN



made. But the inert substance prepared from glands which have been crushed, dried or macerated in glycerin, contains very few active principles. For this reason, the application of the method of Brown-Sequard has not realised the hopes raised by it and has been almost completely abandoned. A bad technique applied to a sound principle has done incalculable harm to the discovery.

Since the time Brown-Sequard put forward his idea that regeneration could be brought about by the hypodermic injections of testicular emulsion, the view that senile changes are due to failure of the internal secretion of the glands, has become popular. The thyroid, the ovary, and the testes, singly or in combination with one or more of the glands found in the body, have been incriminated.

This has led to vigorous research on the internal secretion of all the glands; a store of knowledge has accumulated; and a new science of endocrinology has come into existence. Lorand [1] regards old age as a disease caused by the degeneration of not one, but several of the endocrine glands. Biedl[2] expresses the same view by referring old age to a disturbance of the

1. A. Lorand. *Old Age Deferred*, Philadelphia, 1921.
2. A Biedl. *Endocrinology*, Los Angeles, 1921.

endocrine balance.

Investigation on Thyroid Gland

The early investigations of Cocher, Minkowski, and Graves, on the physiology and pathology of the thyroid gland, have been carried further by a host of workers in this field. The stimulating effect of thyroid secretion on growth and metabolism, shown both experimentally and clinically, and the therapeutic triumph of thyroid treatment in hypothyroidism and myxoedema, seem to justify the view that failure of thyroid function plays an important part in reducing the capacity for multiplication and regeneration of cells. Between the manifestations of hypothyroidism and those of old age, there are undoubtedly striking resemblances, such as dry skin, loss of hair, diminished mental and bodily energy and increased amount of interstitial fibrous tissue. In some respects, myxoedema and cretinism imitate the senile state; myxoedema has indeed been described by Gilford as more than a simulation and as the best example of secondary senilism.[1]

But myxoedema is a very different condition from healthy old age, which does not

1 H Gilford *The Disorders of Post-natal Growth and Development*, London 1911

present the picture of a complete loss of thyroid function. Old age cannot, therefore, be regarded as being due to athyroidism.

Old Age not Due to Athyroidism.

Usually atrophy of the thyroid accompanies that of the senescent body as a whole. Pathological changes do occur in the thyroid, especially in women, during advancing years. It is in instances like these that thyroid feeding produces such improvement that it has revived in our day the hope of an elixir of life and perpetual youth. It is not improbable that the administration of extract of thyroid gland may, by preventing high blood pressure, delay or obviate the onset of arterio-sclerosis, and so stave off senility due to this cause. Three years ago, a brilliant investigation revealed the exact molecular structure of the substance—thyroxin—which is directly responsible for these effects in the thyroid secretion.

The researches on the internal secretion of the pineal body have left no doubt that this gland has a restraining influence upon development at puberty and on the sexual organs. In cases of precocious puberty in either sex, it has been found usually that the pineal body has been destroyed by a tumour.

The Pineal Body.

Function of the Pituitary Body.

The functions of the pituitary body, a very small composite gland, consisting of an anterior and a posterior lobe, have been found by the researches of Biedl, Cushing, Aschner, Smith, Eagle, Steinach, Zondek, Ascheim, Long, and Evans to be of the greatest possible interest. The hormone of the posterior lobe of the pituitary is concerned with the maintenance of a normal tension in the involuntary muscles, in the blood vessels, in the intestines and in the uterus The hormones of the anterior lobe of the pituitary on the other hand, are at least three in number :—(1) Evans' hormone, which promotes growth in body, (2) Prolan A, of Zondek and Ascheim, which stimulates the activity of the reproductive gland, and (3) Prolan B, of Zondek and Ascheim, which inhibits the activity of the reproductive gland. Giantism, acromegaly, pituitary, obesity, and dystrophia adiposogenitalis are the outcome of morbid changes in the anterior lobe of the pituitary.

Activation of Specific Hormones.

Observations on animals and human beings lead us to infer that the ripening of the reproductive glands at puberty check and arrest the function of the anterior pituitary, slackening

and at length stopping the growth. Experimental evidence is quite abundant to show that changes in the reproductive glands (produced by castration, pregnancy, Steinach's operation or gonad grafting), lead to marked changes in the pituitary. The researches of Steinach, of the American investigators, Long and Evans, and the German scientists, Zondek and Ascheim, show that in addition to promoting growth in the body, the anterior pituitary hormone reactivates the specific hormones produced in the male and female sex-glands.

Steinach's Researches on the Anterior Pituitary.

In 1929 Steinach published the results of his researches on the action of the pituitary as an activator of the hormone of the reproductive glands.[1] He used soluble extracts of the anterior pituitary on male animals. By injecting it he produced premature sexual ripening in infantile rats; they showed a marked development of the external and internal reproductive organs much in advance of their years, and behaved in respect of their potency like male adult rats. He was also able to

1 Steinach und Kun. *Die entwicklungsmechanische Bedeutung der Hypophysis als Aktivator der Keimdrusensekretion*, Urban und Schwarzenberg, Berlin.

produce complete morphological and functional sexual maturity in animals, the development of whose masculinity had been arrested. He found that after repeated injections of anterior pituitary hormone, the appearance and the functional capacity of senile rats were greatly modified; the animals could be described as having been regenerated. Steinach has proved beyond dispute that the anterior pituitary holds sway over the functions of the reproductive gland He has further shown that all the biological phenomena previously evoked by direct treatment of the reproductive glands can be evoked by the introduction of this activating substance, without touching the reproductive glands.

"A Supreme General Sexual Hormone"

Continuing their research on the lines of Long and Evans, *i e*, on the influence of the anterior pituitary hormone on the phenomena of rut in female animals, Zondek and Ascheim made a detailed investigation into the changes produced in the uterus and the ovaries, and came to the conclusion that the anterior pituitary hormone acts as an exciting cause to ovulation and declared it to be a "supreme general sexual hormone".

H. Benjamin has made extensive use of the

activation of the anterior pituitary in order to bring about regeneration. He has had recourse to both X-rays and diathermy of the pituitary. Diathermy of the pituitary in women menstruating at the time, tends markedly to increase the flow; it has succeeded in re-establishing menstrual flow in women after climacterium and has induced vigorous menstruation in women suffering from infantilism. It undoubtedly helps to activate the ovarian cycle.

The Adrenal Glands.

Following the early researches of Addison, the physician who has given his name to the disease in which the adrenals are destroyed by tubercle or a new growth, a great deal of work has been done on the hormone produced by the adrenal glands. It was the first hormone whose chemical formula was worked out. Since the discovery of the chemical formula, it has been actually produced synthetically. It has been shown that this hormone has an important influence upon muscular tension and upon the activity of the heart. Adrenalin is extensively used in surgery as a styptic and an adjuvant in local anæsthesia, and also treatment of shock and bronchial asthma.

The pancreas is a ducted gland and produces internal as well as external secretion. It

thus resembles the testes in its structure and function. We should take special note of the research conducted in connection with this gland, as having some resemblance to that conducted on the testes for the study of its internal secretion. It has long been known that the secretion of the pancreas is essential for the splitting up of the fats in digestion and absorption of fatty bodies. Experimental removal of the gland in animals, however, showed not only defective fat digestion but brought about the onset of diabetes which proved quickly fatal. Thus the idea gained ground that the pancreas must pour an internal secretion into the blood, which is concerned with the regulation of saccharine metabolism But attempts made to treat diabetes by administering the expressed juice of animal pancreas or by transplantation of the gland, had little or no effect.

Experiments on Pancreas.

Langerhans had discovered islands of cells lying between the lobes of secreting cells of the pancreas, which differed entirely in structure from the latter cells, and which seemed to have nothing to do with them Banting, and his fellow-investigators of Toronto, were able to prove that the islands of Langerhans produced an

internal secretion. They succeeded in isolating the hormone and called it " insulin ".

Physiologists have known that those glands atrophy whose excretory duct is ligatured. The secretion of the glandular cells accumulates behind the seat of ligature and the pressure within the duct increases, resulting in the flattening out of the secretory cells and leading at length to their destruction. The Toronto doctors found that, after the excretory cells had, by degrees, atrophied by ligaturing the pancreatic duct, there resulted a pancreas consisting mainly of endocrine tissue—the islands of Langerhans—and, therefore, well suited for the extraction of the hormone they required. That was how insulin was first obtained. Later on, simpler and improved methods of preparing insulin were discovered. During the course of these experiments on animals, ligature of only some of the branches of the pancreatic duct instead of the whole, was found to increase carbohydrate tolerance. If the difficulties of operating on the pancreas were not so great, ligature of some of the branches of the duct would certainly have been found the ideal way of treating diabetes. The analogy of these experiments to Steinach's operation for regeneration is quite striking.

The sex-glands—the testes and the ovaries—contain the germ cells, and the interstitial cells, which differ from each other in structure, function and reaction to external influences. Thus the germ cells, though dominant, are more susceptible to damage, for example, by ligature of the vas deferens, by pressure as in the case of a cryptorchid, by transplantation or by exposure to X-rays. It is stated that when the seminal tubules are active and prominent, the interstitial cells are scanty; and, conversely, that when the seminal tubules atrophy, the interstitial cells multiply.

Sex-glands and their Internal Secretion

The earliest work on the internal secretion of the testes was done on animals by the French investigators, Bouin and Ancel, by means of vaso-ligature.[1] They recognised the important functions of the internal secretion of the reproductive glands and their dependence on the interstitial cells. They called them "the interstitial glands" in order to emphasise their character. Then came Steinach's epoch-making work. He recognised the bearing of "the puberty gland", by which name he designated the interstitial cells, on the chief phases of animal life, and turned his knowledge to thera-

1 Bouin and Ancel. *Compt. rend. Acad. Sc. Paris*, 1903.

peutic account. According to Steinach[1], Kuntz[2], and others, after ligature of vas deferens in animals there are two stages: (1) the seminal tubules atrophy while the interstitial cells multiply, and (2) after some time the seminal tubules regenerate while a certain amount of increase in the interstitial cells persists. Nathan[3] ascribes the regeneration of the seminal tubules to the influence of the interstitial cells, which he considers act like young connective tissue by favouring growth. The interstitial cells of Leydig in the testes and the lutein cells of the ovary are regarded as responsible by their hormones for the secondary sex characteristics by Bouin and Ancel, Steinach, and K. Sand[4].

Interstitial Cells as Sex Determinants.

Sir Frederick Mott,[5] who has extensively investigated the character of the interstitial cells, especially in connection with dementia praecox and other forms of mental degeneration, concludes that in fœtal life the interstitial cells act as sex determinants,

1. E. Steinach. *Verjuengung durch experimentelle Neubelebung der alternden Pubertaetsdrusen.* J. Springer, Berlin, 1920
2. A. Kuntz. *Endocrinology*, Los Angeles, 1921.
3. Nathan. *Presse Med. Paris, 1922.*
4. K. Sand. *Journ. de Physiol. et de Path. gen.*, Paris, 1921.
5. F. W. Mott. *Brit. Med. Journ., 1919* and *Proc. Roy. Soc. Med., 1922, Sect. Psychiat.*

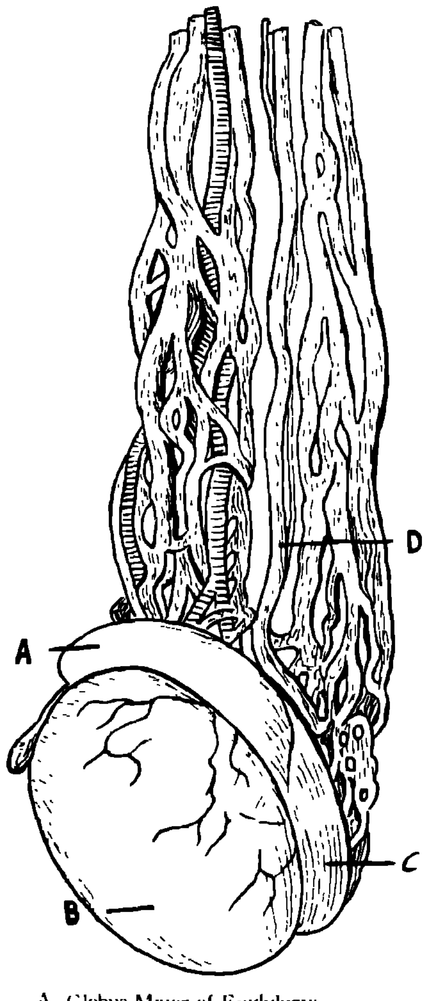
and that later in life they are responsible for the sexual appetite. It has been argued that atrophy of the interstitial cells is the cause of senescence, and Kenneth Walker's[1] observation that the interstitial cells of the testis show a gradual diminution in number from the age of about 30 years, might be quoted in favour of the contention that atrophy of these cells plays a part in the production of senescence.

Steinach's Experiments.

The dramatic experiments on rats carried out by Eugene Steinach[2] began in 1894 and have been carried on continuously ever since. His work removed the technical difficulties of testicular transplantation by utilising the organism's own powers for purposes of regeneration by means of a simple operation of vaso-ligature and vasectomy. As a result of this, the glandular tissue became atrophied through stasis and back pressure of the seminal secretion while the interstitial tissue increased. Through the increase of this tissue, which is the incretory portion of the testicle, he was enabled to produce signs of regeneration.

1. K. Walker *Brit. Med. Journ.*, *1912*
2. E. Steinach - formerly Professor of Physiology in the University of Prague, now Professor of Biology in the University of Vienna and Director of the Physiological Section of the Experimental Biological Institute, Prater, Vienna.

DIAGRAM OF TESTICLE WITH VAS DEFERENS AND BLOOD VESSELS



A Globus Major of Epididymis
B Body of Testis
C. Globus Minor of Epididymis
D Vas Deferens

In Steinach's sense, rejuvenation (or regeneration, as I prefer to call it) meant that through the increased output of testicular hormone, an impulse was given to the aging organism, which stimulated its entire metabolism. All the endocrine mechanism became engaged in the action and thus cellular regeneration resulted to a certain extent.

Steinach's experimental works were:—(1) "Feminisation of Males and Masculinisation of Females"[1], in which by implantation of sex-glands in castrates, he proved that secondary physical sexual character and mental sexual character were dependent on these implants. These experiments also proved that the sexual act was dependent on erotisation of the central nervous system, and that the latter resulted from the chemical action of the internal secretion of the testicle. (2) "Increased Action of the Internal Secretion in Hypertrophy of the Puberty Gland"[2], in which sexual precocity and hyper feminisation in a virgin female guinea pig were produced by exposing the ovaries to Roentgen rays, and thus destroying the generative elements and stimulating the interstitial cells of the sex-gland. He also con-

1. E. Steinach. *Zentralblatt fuer Physiologie, 1913.*
2. E. Steinach. *Archiv fuer Entwicklungsmechanik, Bd. 42.*

ducted experiments in feminisation, masculinisation, and artificial hermaphroditism by means of implanting sex-glands in late castrated animals. The histological examination of the implants showed proliferation of interstitial tissue and disappearance of the seminiferous tubules. These experiments confirmed Bouin, Ancel, and Tandler's researches in attributing specific sex-character to the action of the interstitial tissue. The work done in connection with (3) "Sexual Instinct and True Secondary Sex-character, as a Result of the Incretory Function of Sex-glands"[1]; in relation to (4) "Deliberate Transformation of Male Mammals into Animals with Marked Feminine Sex-character and Feminine Psyche"[2] in proof of "Feminisation of Males and Masculinisation of Females"; and in explaining the relative quantities of differentiation of the cells of (5) "Puberty Glands and Hermaphroditism"[3], led naturally to the practical consequences of these scientific findings in his work on (6) "Attempts at Rejuvenation". As the final outcome of all the earlier experiments by Steinach came his work on (7) "Experimental Regeneration of

1 E. Steinach, *Zentralblatt fuer Physiologie*, 1910.
2 E. Steinach, *Pflügers Archiv,* 1912.
3 E. Steinach, *Archiv fuer Entwicklungsmechanik*, Bd. 12, 1916.

MASCULINISATION



1



2

Two Guinea-pigs of the same litter

1 is a masculinised female

2 is an untreated male

(From Prof. Eugene Steinach's Collections)

FEMINISED MALE SUCKLING



(From Prof. Eugene Steinach's collections)

Aging Puberty Glands"[1].

He conclusively showed that the phenomena of puberty and of sexual development, both physical and psychical, are governed by the internal secretory cells of the sex-glands. He castrated young male rats and implanted ovaries into them.

Sexual Development Governed by Internal Secretory Cells.

They failed to develop the secondary sexual characters of the male, and developed those of the female instead. The penis ceased to grow, or diminished in size, the fur and the breasts took on the female type and the animals approximated very closely to the female build. They were changed also as regards the direction of their sexual desire, so that they were not attracted to the female as they should have been normally but sought male rats and tried to incite them to intercourse. Further they exerted now the same attraction over males as females normally do. Stranger still, such feminised males actually suckled litters of young rats belonging to other females. In young females whose ovaries were removed and in whom testicles were transplanted, analogous results were demonstrated.

Steinach took young rats, removed their sex-

1. E. Steinach. *Archiv fuer Entwicklungsmechanik, Bd. 46, 1920.*

glands, and implanted into them one testicle and one ovary, and thus produced all varieties of hermaphrodites and homo-sexuals. He came to some definite conclusions as a result of these experiments: that there is a rudiment in the early embryo which normally differentiates into a predominantly male or predominantly female sex-gland and, as a result, the individual is pronouncedly male or female as the case may be. Should, however, the differentiation be incomplete, a hermaphrodite results, the degree of hermaphroditism depending on the relative activities of the male and female elements in the puberty glands.

He demonstrated the effects of castration and implantation of testicles on the secondary sexual character of the male rat. If a young male is castrated, it grows to a normal male in size but the seminal vesicles, the prostate, and the penis remain quite infantile. If, however, a testicle is implanted in such an early castrate, the seminal cells of the graft atrophy, but the interstitial cells proliferate. As a result, the sexual characters of the animal become almost equal to those of a normal male and sometimes even exceed them, and the sexual impulse is similarly affected. The animal may not only be masculinised but even hypermasculinised. Analogous



Above: A [illegible] rat [illegible] of advanced senility, before Steinach's operation.
Below: The same rat three and a half months after Steinach's operation. Lived for ten months after operation.

(From Prof. Eugen Steinach's collections)

results in feminisation and hyperfeminisation have been obtained in spayed females by ovarian implantation or by exposure of ovaries to X-rays or by diathermy.

Regeneration by Re-activation of Puberty Glands.

From these experiments Steinach came to believe that the vigour of the individual depended on the puberty glands and that by re-activating them in aging individuals, regeneration is possible. He found that in apathetic senile rats with degenerative changes in the testes, the pituitary and the thyroid, ligature or section of one vas deferens causes atrophy of the seminal tubes and active growth of the interstitial cells; the hormone thus provided stimulates the thyroid, pituitary and brain, and the rat is regenerated, the sexual instincts and emotions become active, and it may even have offspring. When relapse into senility occurs, a repetition of the operation on the other side brings about a further regeneration. And, later, the same result is effected by grafting the testes of a young rat. In this way life is definitely prolonged. This procedure has been advocated by Steinach for application to man.

Steinach conducted his regeneration experiments equally successfully on female rats. The symptoms of senility generally in the female rat

are identical with those in the male—weakness, emaciation and loss of hair—but the changes in the sex-organs are naturally different from the male. The sexual condition manifested by the senile female is that she does not display any interest in the male, nor is she attracted by him. The uterus and ovaries are pale and shrivelled, the vagina is flaccid and the nipples atrophied. Ligature or section of the Fallopian tubes had no effect on the symptoms of senility in a female rat; but Steinach and Holzknecht succeeded by giving carefully regulated doses of X-rays to ovaries, in increasing their size as well as of the uterus and the breasts. The most successful method of regeneration in the female rat, however, was by transplanting an ovary from a young, healthy female. In the process of regeneration following this, the animal's own ovaries participated.

Steinach's Conclusions

As a result of his experiments, Steinach's conclusions may thus be summarised :—(1) That the sex-glands act in a specific manner and the formation of hormone in the sex-gland is quite independent of the formation of the excretory procreative cells. (2) That the formation and maintenance of the somatic and psychic sexual characters are depen-

dent on the hormone secreted by the sex-glands. (3) That by interfering with the excretory cells by ligature or section of the excretory duct, by implantation of the sex-glands, or exposure to Roentgen rays, a proliferation of the incretory cells is produced which, in its turn, causes increased production of the hormones. (4) This increased production of hormone, in persons aging prematurely or otherwise, causes re-activation of the entire incretory mechanism and, through it, a general regeneration. (5) Among the physical signs of regeneration are renewed growth of hair, increase in weight and muscular strength, and improvement in carriage. (6) Among the signs of functional improvement are increase in appetite, increase of metabolism, disappearance of dullness and fatigue, reawakening of sexual desire and restoration of potency. (7) Unilateral ligation and section is usually quite sufficient, the testis on the other side is included in the process of regeneration which follows and the animal becomes capable of producing offspring. (8) Whether the operation would actually prolong life in man is difficult to predict; at least in rats, life was definitely prolonged. But regeneration, postponement of senility and, in some favourable cases, restoration to a condition of

youthful vigour, are quite possible.

Steinach's experiments on animals, which form the basis of all recent work on regeneration and allied subjects, have received confirmation from a host of workers in this field of biology and practical medicine.

Ruzicka[1] experimented on senile and regenerated animals. He studied the declining course of the process of life which consists of progressive condensation of the living substance, or hysteresis of protoplasm. He attributes the aging of the individual to this hysteresis or drying process, with its inhibitory action on metabolism. He found that the regenerated animals showed a lower degree of hysteresis in their protoplasm than the physiologically old animals. Steinach's works received an unexpected support and a justification for calling the results of his operation true cellular rejuvenation.

As a result of extensive research, K. Sand, of Copenhagen, is of the opinion that the production of hormones is to be ascribed chiefly to the cells of Leydig and only secondarily to the cells of Sertoli or other cells lining the seminal

1 Ruzicka (i) *Ueber Protoplasmahysteresis und eine Methode zur direkten Bestimmung derselben. Pflugers Archiv., Bd. 194. Heft I/2.* (ii) *Die Protoplasmahysteresis und das Verjuengungsproblem. Deutsche Medizinische Wochenschrift, 1922. No 28.*

TREFF THE POINTER



Just before Steinach's operation



Six months after Steinach's operation

(*From Prof. K. Sand's collection*)

canals[1]. An interesting experiment was carried out by him on "Treff", a male short-haired German pointer, which has become classical[2]. When Sand saw Treff, the dog was more than 12 years old, and he thought it quite hopeless to try the experiment of regeneration on him. Treff's attitude, dull glance, bleary eyes, terrible emaciation, miserably thin coat, slinking, faltering gait and dejected appearance produced an impression of hopelessness. He lay in a corner of the kennel and remained quite indifferent to the rats, guinea pigs and birds about him, which normally should have been very interesting to a hunting dog.

On May 23, 1921, Sand removed 3-4 cm. of the right epididymis, under ether, ligatured and touched the two ends with paquelin cautery. In October, 1921, the dog was brought to the hospital where he was seen by a number of doctors. All expressed astonishment at the profound change in his condition. He was lively and playful, chased the other experimental animals

1. K. Sand. (i) *Experiments on the Internal Secretion of the Sexual Glands, especially on Experimental Hermaphroditism. Journ. of Physiol., Dec. 1919.* (ii) *Etudes experimentales sur les Glandes sexuelles chez les Mammiferes., Journ. de Physiol. et de Pathol. gen., 1921, S. 305.*

2. K. Sand. *Vasektomie chez un Chien comme Experience de Regeneration. Comptes rendus de la Soc. de Biol., Dec. 1921.*

and broke the rats' cage. The right testicle was very tense, the left was markedly smaller. He had a good appetite, micturition and defaecation were normal, and his whole appearance was quite altered.

When in Cairo in 1898, Serge Voronoff[1] became greatly interested in the profound differences between normal persons and the eunuchs castrated in childhood and similar but less marked differences in those castrated after puberty. From these observations he concluded that the function of the testicle was to activate vital energy rather than to act purely as a sexual stimulant, that healthy men had normally functioning testicles, while enfeebled persons owed their condition to the exhaustion of this source of energy.

Voronoff's Researches

He commenced his researches at the Physiological Station of the College of France, in 1913, and four years later his experiments on transplantation of testes in animals commenced. His researches led him to conclude that if an organ was nourished by the serum of the organism, it would live after graft-

1. S. Voronoff. (i) *Vivre. Etude des Moyens de relever l'Energie vitale et de prolonger la Vie.* Paris, 1920. (ii) *Greffes Testiculaires.* Paris, 1923. (iii) *Quarante-trois Greffes de Singe à l'Homme*, Paris, 1924.

ing and take root in its new host. Hence he chose the serous cavity surrounding the testicle as the best site for transplantation, as it would be bathed in serum. For his testicular transplantation experiments he chose the sheep and goat because of the marked differences between the sexes in these animals. Voronoff took testicles from young rams, two or three years of age, cut them into four, five and even six slices, and grafted them into the scrotum of the senile rams. In a few months striking changes occurred ; appetite was regained ; the wool grew thick and strength increased. They became bold, aggressive and youthful, manifesting energy and vitality. In order to make sure that these changes were due to testicular grafts and not due to improved feeding, Voronoff removed the grafts at the height of regeneration and vigour ; in spite of continued good feeding, the animals in a few months became depressed, feeble, and senile again. Experiments on buck-goats castrated at an early age resulted in the abnormal development of fat, with long legs, delicate horns like those of the female, apathetic movements and lack of sexual desire. But animals of the same litter who had testicular transplantation made at the time of castration, showed normal development as if they had

never been castrated.

Experiments with testicular transplantation in apes have been made by Thorek[1], of Chicago. He experimented on apes and after unmistakable onset of impotence caused by earlier bilateral castration, he implanted testicles of other apes which had been subjected to X-radiation so as to destroy the reproductive elements completely and leave only the interstitial cells. He grafted them in the capsule of the kidneys, after destroying the tunica albuginea of the testes and laying bare the tunica vasculosa. The operation proved successful in five out of six cases.

He believed that as the results were such as follow the production of increased hormone, it was certain at any rate in apes, that the testicular hormone was produced by the interstitial tissue; Leydig cells were increased, the seminal canals were quite empty, containing no spermatogonia and there were no Sertoli cells. He, therefore, regards Sertoli cells as supplying nutrition to the generative elements of the tubules and denies that the spermatogonia or Sertoli cells have any part in the production of the hormone.

1. Thorek. (i) *The Present Position of Testicle Transplantation in Surgical Practice.* *Endocrinology*, 1922. (ii) *Endocrinology*, Jan. 1924.

A. Lipschutz[1] has done extensive experimental work on animals in his laboratory, especially in producing hermaphrodites and homo-sexuals by operating in such a way that an animal has both male and female reproductive glands. He was the first to observe the transformation of the clitoris, in experimental masculinisation, into an organ like the penis. His very extensive experimental work produced conclusive proof for the existence, localisation and activity of the puberty glands. His published works on sexual transformation cover a wide field.

Harms'[2] implantation experiments on senile dogs produced striking results, especially as regards the disappearance of the papillomata of old age.

Pezard[3] produced hermaphroditism by transplantation in fowl.

Kolb's[4] experiment on a she-goat is instruc-

1. A Lipschutz. (i) *New Experimental Data on the Question of the Seat of the Endocrine Function of the Testicle. Endocrinology, Jan. 1923, No. 1.* (ii) *The Internal Secretion of the Sex-glands.* Heffer and Sons, Cambridge.
2. Harms. *Problem der Geschlechtsumstimmung und sogenannte Verjuengung. Naturwissenschaften, 1921, No. II.*
3. Pezard, Sand et Caridroit. *Production experimentale du Gynandro-morphisme biparti chez les Oiseaux. Comptes rendus de L'Academie des Sciences, Fevrier 26, 1923.*
4. Kolb. *Ueber einen Verjuengungsversuch an einer Ziege. Verhandl. der schweizer naturfuersorgenden Gesellschaft, 1922,* and *Wiener Med. Wochensch., 1923, No. 45.*

tive. A previously senile ovary became again functionally active after transplantation of an ovary taken from a goat three months old.

CHAPTER IV

REGENERATION IN MAN

Primarius Dr. Robert Lichtenstern, the leading genito-urinary surgeon of Vienna, was invited by Professor Eugene Steinach to apply his methods of regeneration to human beings. At first the operation of vaso-ligature and vasectomy was performed by Lichtenstern on patients whose physical condition was markedly bad; this was done during the course of other operations, and without the knowledge of the patient, so that auto-suggestion might be eliminated. The technique applied by Lichtenstern was as follows :—

1. The spermatic cord at the root of the penis and a small patch of skin of the scrotum on the under part were rendered insensitive by local anæsthesia. An incision about 4 cm. long was made in the anæsthetised scrotal skin, the head of epididymis exposed, ligatured with silk in two places, and the vas deferens cut between. The skin incision was then carefully closed.

2. The cord was exposed under local anæsthesia at the root of the scrotum by an in-

cision 3 cm. long and drawn out; the vas deferens was isolated, tied in two places about an inch apart and the portion between the ligatures removed, great care being taken not to injure the delicate vessels and nerves accompanying the vas, as this might cause damage to the testicle. The incision was closed after replacing the cord.

Lichtenstern began Steinach's operation in 1918, and in a few years had made extensive clinical investigations. After very careful consideration of his cases, he expressed his opinion, which may be summarised thus :—1. There were changes in almost all patients after Steinach's operation. 2. Striking improvement of general condition and rapid increase of weight. 3. Physical changes easy to notice objectively; the condition of the skin was most striking, inelastic, dry, scurfy skin became supple, moist, smooth and glossy ; changes in hair were very marked, hair of head and face grew very rapidly and thicker on trunk, pubis and limbs. 4. Development of sexual desire and potency was present in all cases. 5. Increase in mental and physical capacity for work was particularly valuable and important 6. The period after the operation in which these changes took place varied from six weeks to five months, depend-

ing on the complete activity of the puberty glands. 7. In young persons, ligature and vasectomy should be performed only on one side ; if necessary, the other side should be done only after the patient has been duly warned of the sterilising effects of bilateral vaso-ligature and vasectomy. In older persons, bilateral operation is wiser. 8. No bad effects have been noted resulting from the operation.

The *indications* for the operation are :—(*a*) Hardening of arteries with its disagreeable effects on general health, manifested generally in men between 40 and 50, loss of hair, loss of weight, lack of endurance, easy exhaustion after mental and physical effort and decline of sexual desire and potency. (*b*) Normal old age, if no serious organic lesions are present apart from changes natural to age. (*c*) Young adults with deficient erotisation and deficient development of secondary sexual characters.

The *contra-indications* are :—Changes in health caused by chronic infections, *e.g.*, syphilis, tuberculosis, or in cases of malignant tumours.

Testicular Grafting.

In 1915 Lichtenstern started testicular transplantation as a result of Steinach's experiments on animals. He first tried to implant testicular grafts into the scrotum, but the graft got

necrosed, sloughed off or was absorbed. He then chose the site in the groin. After a small incision the oblique muscle was exposed and 2 cm. of the covering facia removed. The site was lightly scarified and half of the testicular graft was sewn around to the muscle with fine silk or catgut, the cut surface of the graft being next to the scarified surface of the muscle, the tunica albuginea was sewn to the muscle, leaving a small clear space around the graft tissue to help early vascularisation of the graft. The layers of facia and skin were sutured and dressing applied, and the patient kept quiet in bed for 10-12 days. It was best to have the donor and the recipient in the same operating room to facilitate the grafting. Absolute asepsis, gentle handling, and great care were required to secure the best conditions for the graft to take. It was also necessary to examine the donor to exclude presence of diseases, especially tuberculosis and syphilis.

Lichtenstern[1] treated cases of eunuchoidism

1 R. Lichtenstern. *Bisherige Erfolge der Hodentransplantation beim Menschen. Jahreskurse fuer aerztliche Fortbildung, xi. April 1920. Die Erfolge der Altersbekaempfung beim Manne nach Steinach. Berlin, Klin. Woch., lvii, No. 42, Oktober, 1920. Mit Erfolge ausgefuehrte Hodentransplantation am Menschen. Muensch. Med. Woch., 1916. Die freie Hodentransplantation beim Menschen Ver. Deutsch Naturf. u Aerzte in Nauheim, 1920. Ueber Transplantation von Kleindrusen. Verhandl. d. 35 deutschen Kongress f. innere Medizin, xxv.*

and homosexuality besides impotence and senility by the method of testicular transplantation, and succeeded in curing these conditions in a majority of his cases. In some of his cases of homosexuality, the results were most remarkable and lasting.

Serge Voronoff is the next important investigator in this field. His experiments on animals described previously led him to the conclusion that transplanting of testicles in human beings in cases of testicular exhaustion due to deficiency or old age, or due to congenital maldevelopment, or caused by inflammation such as gonorrhœa, syphilis, or tuberculosis, would lead to restitution of the lost hormone, and regeneration in the individual. Human testicles were difficult, if not impossible, to procure, except in cases of undescended, atrophied or otherwise abnormal testicles. French law did not permit the removal of any organs from young and healthy victims of fatal accidents, and the difficulties of procuring the organs from condemned criminals immediately after death were insuperable. He, therefore, decided to try implantation of the testicles of apes, which were closely allied to human beings. Among these, the orang-outang, the gorilla, and the chimpanzee were most closely related to human

beings. He chose young adult monkeys, free from any infective disease, as donors.

He chose the site of the graft after a great deal of experiment and deliberation. He had found previously that the abdominal wall, the groin, the thigh, the peritoneal cavity and the capsule of the kidney all led to the shrinking, absorption or necrosis of the graft; the best place was the tunica vaginalis, where the graft was kept at a temperature best suited for it, and bathed in serum during the early period necessary for its vascularisation. In human beings he was often unable to make the graft into the cavity surrounding the testicle, but got equally good results by implanting the testicular fragments on the outside of the parietal layer of the tunica vaginalis.

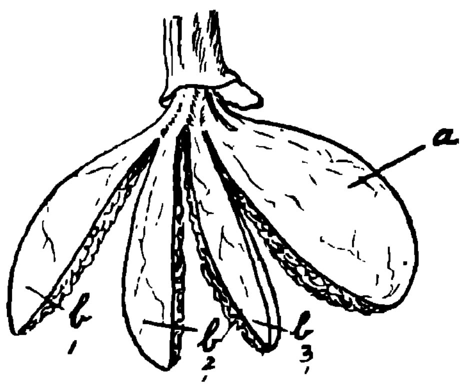
The monkey was anæsthetised with chloroform in a special cage devised by Voronoff.

Technique of the Operation

Simultaneously the patient was also prepared on an adjacent table and given general or local anæsthesia. The assistant surgeon removed the monkey's testicle with its covering of tunica vaginalis. The chief surgeon made a lateral incision in the patient's scrotum down to, but not involving, the tunica vaginalis. The monkey's testicle was removed

VORONOFF'S METHOD OF GRAFTING

Diagram showing Testicle of the Donor

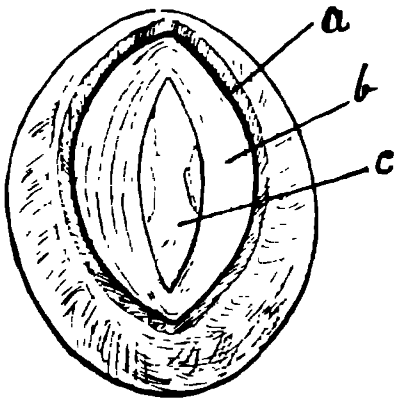


a Half slice

*b*1 }
*b*2 } The other half sliced in three.
*b*3 }

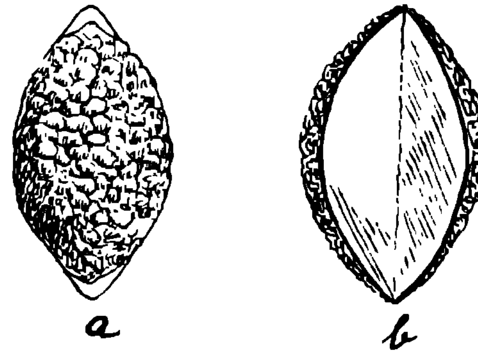
VORONOFF'S METHOD OF GRAFTING

DIAGRAM SHOWING SCROTAL INCISION



a Incision in scrotal skin
b Subcutaneous layer
c Parietal layer of tunica vaginalis

DIAGRAM SHOWING TESTICULAR GRAFTS



a Showing the raw glandular aspect
b Showing the aspect covered by tunica albuginea

from its tunica and the epididymis cut away, the testicle being divided vertically in two halves, each half again being longitudinally divided into three slices, the slices being kept attached at the root and covered with warm sterile lint until the fragments were placed on the outer layer of the patient's tunica vaginalis with their raw surfaces next to the outside layer, which had been gently scarified previously, and fixed in position with cat-gut stitches. There should always be some space left between each fragment so that their nutrition is not interfered with, otherwise necrosis will occur. The skin was closed with silk sutures and dressing applied. The fragments of testicles should be neither too big nor too small; if they are too big, they necrose for want of sufficient blood supply, if too small they get completely absorbed. In cases of hydrocele, Voronoff grafted the testes into this cavity with the raw surface applied to the inner surface of the parietal layer of tunica vaginalis. He preferred the patients to remain in hospital for four to seven days after the operation.

The following findings are given by Voronoff on the basis of his earlier operations :—
1. That patients showed increase of energy and vigour and often recovered sexual power even

after a long period of impotence, but potency was not improved or restored in every case. 2. There was always a physical and mental improvement. Psychic changes were manifested by improved memory and improved capacity for mental work. 3. The physique improved considerably, obesity decreased owing to better metabolism. Frequency of urination due to enlarged prostate was diminished. High blood pressure was considerably lowered and defective sight due to old age improved. He believed that the epithelial cells of the seminiferous tubules in a graft became transformed into reticulated tissue and furnished plasma, the absorption of which into the organism brought about these changes.

He gave the following *indications* for testicular grafting :—(*a*) Infantilism as regards sexual organs. (*b*) Congenital deficiency in the development of the testes causing delayed puberty, weakness as regards virility. (*c*) Absence of testes, congenital, due to accident, or surgical removal. (*d*) Arterio-sclerosis with circulatory hypertonia. (*e*) Senility, premature or physiological, with general decay and gradual loss of bodily functions. (*f*) Dementia praecox which, according to Mott, was caused by insufficiency in testicular hormone.

Among the host of workers who have published their results, only a few prominent names can be mentioned. Dr. Peter Schmidt, of Berlin, published his results in a book entitled, "Theory and Practice of the Steinach Operation". Later, he published a comprehensive work which was translated into English in 1931, entitled "The Conquest of Old Age". His case list is fairly extensive and covers a variety of conditions from senility, congenital or acquired sexual weakness, absence of testes, senile tremors, paralysis agitans, homo-sexuality, neurasthenia and dystrophia adiposo-genitalis, insanity and cachexia due to malignant tumour. He recommends double ligation with thick and thin thread and stitching of the proximal end of the distal part of the vas deferens to the upper angle of the incision in the tunica vaginalis. He does not favour ligation between the testis and epididymis because of the dislocation of testicle, congestion, and increase of tension. Nor does he favour ligation of the vas near the inguinal ring, as in old people with feeble flow of the semen, the effect on the tissues of the testicle would be very weak, while in young persons there would be risk of spermatocele of the vas. He recommends ligation of the vas deferens near its junction with epididymis.

In a general survey of his cases, which were most carefully observed, he found his results accorded with those observed by Steinach in rats, and by Sand in his dog "Treff". He regards half his cases as completely successful. He made a careful list of somatic and psychic changes found after the operation in his cases as under :—

1. Somatic changes. (*a*) Increase in weight ; (*b*) Improvement in skin condition with or without increase of subcutaneous fat; (*c*) Changes in growth of hair ; crops of fresh hair in place of previously thin ones, quicker and thicker growth; softer character of new hair, and better pigmentation; (*d*) Increase of muscular power ; (*e*) Lowering of blood pressure; (*f*) Better blood supply to the extremities and sex organs showing vaso-motor improvement; (*g*) Improvement in eyesight; (*h*) Increase in appetite and oxygen intake; (*j*) Improvement in sexual potency; (*k*) General symptoms of old age and arterio-sclerosis improved, such as tremor, pruritus, shortness of breath, discomfort in the region of the heart, and sensation of pins and needles in the limbs.

2. Psychic Changes. (*a*) Better memory, greater initiative, and improved mental concentration ; (*b*) Greater self-confidence, plea-

sure in work, joy in life and creative power ; (*c*) Increase in sexual interest.

In cases of very high blood pressure, organic diseases, sexual neurasthenia and hysteria, he advises abstention from any operative interference.

Kenneth Walker, of London, reported on ten cases of testicular transplantation in 1924, and in the same year published, along with Cook, a short paper on "Steinach's Rejuvenation Operation". In his transplantation operations he used undescended or imperfectly descended testicles of boys between 10 and 22, the donors being carefully examined previously to exclude syphilis, tuberculosis, or any other constitutional disease. He either implanted the graft into the cavity of the tunica vaginalis, in the rectus abdominis muscle, or in a subperitoneal pocket. He always used general anæsthesia, divided the testicle into six fragments and implanted the graft with the raw surface next to the lightly scarified tunica, rectus muscle, or abdominal peritoneum as the case may be. He confined his patients to bed for a fortnight. He enlisted the support of physiologists and biochemists to make careful investigations and proved that his operations produced marked alterations in metabolism. Walker and Cook,

though disagreeing with Steinach's interpretation of his histological findings, agreed with him as regards the practical utility of vaso-ligature and vasectomy. They thought that exclusion of any influence of suggestion was not always easy. They found great improvement in cases of paralysis agitans by Steinach's operation.

H. Benjamin[1] has a very extensive case list and has made several communications regarding his researches on Steinach's operation. He does not believe that any harm can result from it. He found the effects of the operation manifesting themselves in about six months. In his opinion cases of advanced senility or impotence caused by some organic disease, such as locomotor ataxia, should not be operated upon. He advised operative interference in normal and premature senility and selected cases of impotence. He used Schmidt's operative technique but sewed up the lower stump to the upper corner of the wound

1. H. Benjamin *Preliminary Communication regarding Steinach's Method of Rejuvenation* N. Y. M. J., Dec. 1921. *Abstract of foregoing Discussion. Int Journ. of Surg.*, Feb. 1922 *The Effect of Vasectomy (Steinach Operation). American Medicine* No 6 Vol xviii, No 8, pp. 435-443, 1922 *Theory and Practice of the Steinach Operation.* N. Y. M. J. and *Med. Record*, August 16, 1922 *The Steinach Operation Endocrinology*, Vol. vi, No. 6, pp. 776-786. 1922.

K. Sand is one of the pioneers of the practice and science of regeneration. Besides his experiments on animals, he has practised Steinach's operation as well as implantation of testicle on a large number of cases. He lays greater stress on the clinical results than on the controversy concerning histological findings. In his opinion, an erroneous technique will spoil the effects of the operation entirely. Instead of ligation of the vas deferens, he prefers to tie and cut the spermatic canal nearer the testis while it is still the epididymis. The effect manifests itself sooner with this technique. He has never seen any ill effects following the operation.

G. F. Lydston[1] reported in the American Journal of Surgery, in 1920, that six years previously he had implanted in his own body a testis removed seventeen hours after the death of a healthy young man of eighteen. Examination after eight days showed the graft to be still living. The part of the graft which was left disappeared in about a year. He practised implantation of sex-glands in both men and women extensively, and published a complete bibliography in 1914. He, therefore, claimed

1. G. F. Lydston. (i) *Transplantation of a Testicle from the Dead to the Living. N. Y. M. J., 1914.* (ii) *Impotency and Sterility with Aberrations of the Sex Function and the Sex-gland Implantation.* Chicago, 1922

priority to Voronoff in this sphere. His conclusions briefly were as follows :—(*a*) Partial or total implantation of human gonads was quite practicable ; (*b*) The gonads from a healthy dead body were as suitable as from a living body ; (*c*) The hormone produced from sex-glands acted as stimulant, nutrient, tonic and reconstructive; (*d*) By implantation, senility might be retarded and longevity increased ; (*e*) Grafting proved beneficial in cases of defective sexual development and mutilation of sex-glands; (*f*) It proved valuable in obstinate cases of chronic skin disease like psoriasis; (*g*) It was of great value in arterio-sclerosis, early dementia, and also in some cases of dementia praecox ; (*h*) He found excellent results in cases of imperfect sex development with feminine characters in males; (*i*) It was not necessary for implant to last permanently to secure good results.

Stanley[1] of St. Quentin, U. S. A., reported on cases operated by implantation of human testicles taken from recently executed convicts, and on others who had ram's testicle implanted

1. L. L. Stanley. (i) *Experience in Testicle Transplantation. Calif. State J Med.. 1920.* (ii) *Testicular Substance Implantation. Endocrinology, Nov. 1921.* (iii) *One Hundred Testicular Substance Implantations. Endocrinology, 1922.*

in them. The conclusions arrived at were given by him as follows :—(*a*) Testicular implantation had an invigorating and stimulating effect on the recipient, sexually as well as mentally and physically ; (*b*) The implant did not live but became necrotic, and during the process of necrosis, some unknown substances were released into the system ; (*c*) The glands of rams seemed to be as effective as human glands. These glands could be preserved for a week or even longer by freezing and immersion in vaseline; (*d*) There seemed to be less likelihood of sloughing out of the implant when placed in the abdomen than in the scrotum ; (*e*) With the abdominal implant, the patient needed to be in bed only for one day ; (*f*) Any means which increased the physical well-being of an individual, as this process did, would tend to increase longevity.

Stanley also practised a very crude method of implanting testicular substance of animals by cutting up the testicle into very minute fragments and injecting these through a wide bore needle into the subcutaneous tissue over the abdominal wall. He carried out a series of 656 injections in prisoners in the State prison of St. Quentin, California. The injections rarely produced local reaction and health was greatly

benefited, the grafts persisting for several months, after which they were absorbed completely. Among his patients there were also a few women. He summarised his results as follows :—In cases of senility, asthma, acne, general asthenia, marked objective improvement was noticed. Testicular substance in general seemed to have beneficial effect in relieving pains of obscure origin, and promoting bodily well-being.

Thorek, of Chicago, applied his experiments conducted previously on apes to human beings and carried out grafts from human beings (homo-grafts), as well as those taken from apes (homeo-grafts). He got good results in many eunuchoid patients with marked feminine stigmata. He offered the following *indications* for transplantation :—(1) Loss of testicle due to trauma, tuberculosis, malignant growth, etc. ; (2) Climacteric disturbances ; (3) Premature senescence in which he thought other glands in combination with the testicle would also prove useful ; (4) Sexual neurasthenia of hormonal origin ; (5) Dementia praecox in which he had seen good results ; (6) Psychoses of puberty of endocrine origin; (7) Dystrophia adiposo-genitalis. Here the pituitary gland should be transplanted as well as the testicle ; (8) Impotence if not caused by tabes, diabetes, or of nervous

origin ; (9) Eunuchoidism, infantilism, and homosexuality of genital origin ; (10) Selected cases of hermaphroditism ; (11) Defective development of the genitals in young people ; (12) Certain forms of sterility ; (13) Chronic nutritional diseases ; (14) Sexual weakness ; (15) Selected cases of undescended testicle ; (16) All cases of disordered function of the testicle.

He offered the following *contra-indications* :—All cases not included in the above list, particularly cases with acute febrile conditions.

Before closing this section, a brief reference to some of the other methods of regeneration may be made.

OTHER METHODS

Steinach showed that other stimuli in addition to vaso-ligature and testicular transplantation could promote the growth of puberty gland. Albugineotomy was one of them. The testicle having been exposed, an incision was made into it along one side for about two-thirds of its length, the testicular substance protruding through the incision was cut away level with the tunica albuginea and then the incision was closed with fine catgut sutures. After closing the skin incision, and dressing, the patient was kept in

Albugineotomy.

bed for four or five days, the operation being usually followed by a moderate swelling of the testicle.

The way in which this operation proved beneficial was explained thus. The change in the intra-testicular tension stimulated new growth in the substance of the testicle as a whole. Along the site of the incision, atrophy of the spermatoblastic tissue and hypertrophy of the puberty gland tissue took place. This method of reactivation of the testicle was applied instead of Steinach's operation where previous inflammation had already blocked the vas deferens.

X-ray Stimulation

It has been repeatedly noted that the effect of X-rays upon the reproductive gland is elective, *i.e.*, the tissue forming the reproductive cell is injured whereas the puberty gland tissue is stimulated to increased growth. The recent work of Kriser and Lenk in Vienna on human testicles under X-ray exposure has proved without doubt that these exposures reduced progressively the number of spermatozoa in the semen; on the other hand the patient's vigour and potency progressively increased. So far, however, as therapeutic practice is concerned, X-ray stimulation of the human testicle is not

of much importance as a means of regeneration.

Diathermy.

Diathermy can be applied to the male reproductive gland by means of specially constructed electrodes. Its use, however, should be confined only to those cases in which the patient has strong objections to operative interference. It may also prove useful in young men with delayed or insufficient development of puberty.

Chemical Method of Regeneration. (Doppler's Method).

For years, Doppler[1] of Vienna has been "phenolising" the arteries of the reproductive gland in men and women and has recently published his results. It would, therefore, be of interest to say a few words about the theory and practice of his method.

In most cases arterio-sclerosis is nothing more than a functional change in the walls of the arteries, the muscular tissue in the arterial wall being in a condition of undue tension producing narrowing of the calibre of the arteries. It is well-known that the exciting cause of this contraction proceeds from the sympathetic nervous plexus which surrounds the arteries.

1. Karl Doppler. *Die Laesion des peripheren Stromhahnsympathikus mittels lokal applizierter chemischer Agenzien und ihre Effekte., Med. Klinik, 41/45, 1931.* Urban und Schwarzenberg, Berlin, No. 24

Physicians have been trying for years to find some means of reducing the stimulus proceeding from the sympathetic nerves and Leriche has actually suggested surgical removal of part of the sympathetic plexus surrounding the great blood vessels.

Working on these lines, Doppler found that "Phenols" had an elective paralysing influence upon the sympathetic nerves, and he, therefore, began painting the arteries of elderly persons suffering from arterial spasm with solutions of phenol. Judging from his report, the results are very favourable.

REGENERATION IN WOMEN

As there is no operation in women analogous to vasectomy and vaso-ligature, owing to the fact that the Fallopian tube, which serves to convey the ovum from the ovary to the womb is not an excretory duct, and is not connected structurally with the ovary, other methods for regeneration have been resorted to. Transplantation of human ovary is difficult mainly owing to dearth of material; even if a donor could be found, she would have to undergo an abdominal operation, since the ovaries are situated deep in the abdominal cavity. However, gynaecologists occasionally resort to the re-

moval of this organ, and then the ovary can be used for purposes of transplantation. In a majority of cases, however, only ovaries of other mammals can be used. The recipient and the donor should be prepared simultaneously, transplantation being effected without any delay in order to give best results.

Sippel[1], who has had the largest experience, considers the lower part of the anterior abdominal wall as the best seat for the graft. A transverse incision about 2½ inches long is made just below the upper limit of the pubic hair, so that it will be invisible after the hair is grown. The muscular planes are separated and the ovary, divided into two halves, is stitched in place. The patient is kept in bed for 10 days.

He has reported cases in which previously sterile women conceived, and passed through a normal pregnancy after the reactivation of their otherwise normal ovaries had been accomplished by transplantation of discs of ovarian tissue.

Holzknecht[2] reported that in women sub-

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1. Sippel *Die Ovarientransplantation bei herabgesetzter und fehlender Genitalfunktion. Archiv f. Gynaekologie, Bd. 118, Heft 3.*
2. Steinach und Holzknecht. *Erhoehte Wirkungen der inneren Sekretion bei Hypertrophie der Pubertaetsdruse Archiv. f. Entwicklungsmechanik, Bd. 24, Heft 3.*

jected to X-radiation, stimulation of the interstitial tissue of the ovary took place ; lassitude disappeared, complete physical and mental vigour was restored, better circulation and great firmness of the skin was noticed and a decidedly youthful appearance became apparent. The method has, however, fallen into disrepute because of its uncertainty.

Benjamin has also treated women by X-ray and diathermy to combat either incipient or pronounced symptoms of senility.

Diathermy, however, is the method preferred to-day. The exposure of the ovary to diathermy brings about relaxation of the vessels and imitates the effects of the sexual hormone. Peter Schmidt has worked out a method for the use of diathermy to produce reactivation in women at the climacteric ; in accordance with this method, general diathermy, diathermy of the ovaries, and diathermy of the pituitary are undertaken in series. The method needs modification to suit each individual case, but the results are invariably good. He strongly recommends, like H. Benjamin, the extensive use of electricity to activate the anterior pituitary. By pituitary activation of the ovarian cycle, Peter Schmidt has been able to re-establish the menstrual flow in women after the clim-

acterium.[1] Liebesny was able to induce vigorous menstruation in women suffering from infantilism.

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1. Peter Schmidt. *The Conquest of Old Age.*

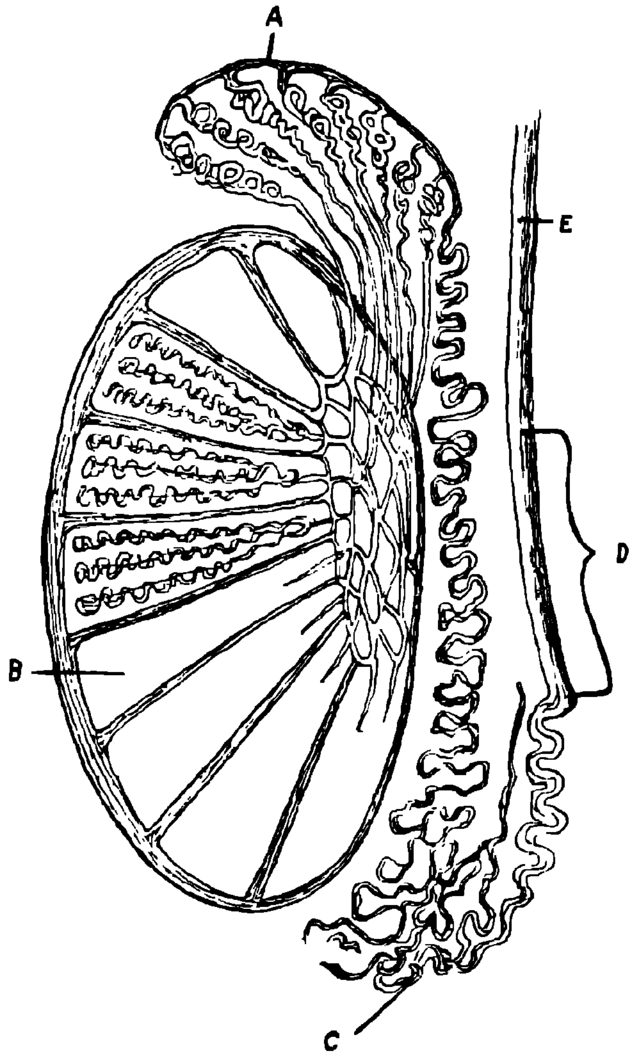
CHAPTER V

AUTO-REGENERATION BY MEANS OF VASO-LIGATURE AND VASECTOMY

This is also called Steinach's operation, after the great biologist and savant, whose experiments on mice and guinea pigs form the basis of all operations for regeneration in man. The technique of the operation is very simple. After exposing the cord by making an incision in the skin, the vas deferens, the duct conveying the semen, is carefully isolated from the blood vessels and the nerves accompanying it. It is ligatured in two places at an interval of an inch and a half from each other, and an inch of it is then snipped off between the two ligatures, the lower end being sewn up to the surrounding tissues adjacent to the upper end, the deeper layers and the skin are sutured, and the patient put to bed, with an ordinary aseptic dressing. It takes generally from 6 to 8 days for the skin wound to heal up, when the stitches are removed and the patient allowed to go out of the hospital.

Many surgeons make a large incision, which is quite unnecessary. An incision about

DIAGRAM ILLUSTRATING STEINACH'S OPERATION



A Globus Major
B Body of Testis
C Globus Minor
D Site of Vaso-ligature and Vasectomy
E Vas Deferens

1″-1½″ in length is quite sufficient. Some surgeons make inguinal incision and remove the vas as it enters the external abdominal ring. This is not the best place for Steinach's operation. Others make scrotal incision and remove the vas just as it emerges from the globus minor, there being a niche between the globus minor and the cord. This is the best place for it. Some surgeons use silk for ligaturing and suturing; others use catgut for ligature and horsehair or fishing gut for suture ; I myself prefer silk for both ligature and suture.

Five Illustrative Cases.

Case I. Dec. 7th, 1926. S. S., property agent, age 69. Patient came supported and stooping; appearance anxious and long-suffering. Complained of painful urination forty to fifty times in 24 hours. Examination revealed enlarged hypertrophied prostate with residual urine, chronic cystitis ; the urine was ammoniacal and full of organisms. The bladder was hypertrophied and contracted.

Patient's general condition showed cachexia due to chronic septic absorption, anaemia, loss of appetite, constipation and flatulence. The heart and lungs revealed nothing abnormal, but the arteries were markedly thickened and the

blood pressure as recorded by mercurial manometer was, systolic 207, diastolic 102. He complained of general apathy and lack of energy. He was obliged, mainly due to urinary trouble, to stay at home and leave all his work in the hands of his sons. He had suffered from loss of memory and lack of concentration for the last five years, and complete loss of sexual desire for the last twelve years. The chief trouble for which he consulted me was urinary. He was at once admitted to my clinic and was put on urinary antiseptics, sedatives, and washing out of bladder.

10-12-26 Patient comfortable, frequency 8-10 times including catheterisation, but straining and pain at micturition persisted. Patient refused the operation of enucleation of the prostate suggested to him.

12-2-27 Steinach's operation of vaso-ligature and vasectomy was performed on both sides in the inguinal areas, under local anaesthesia.

19-2-27 Sutures removed. Patient felt a lot better. More cheerful. Although frequency of urination had diminished to 6-8 times a day, the pain persisted but the urine was now acid, free from sediment and was passed without any straining.

19-3-27. Patient came to my consulting

AUTO-REGENERATION—STEINACH'S OPERATION



[illegible]

Five years after Steinach's operation

rooms of his own accord without being supported, and did not go to the urinal though he had to wait for over two hours. He looked cheerful. His stoop had completely disappeared, his wrinkles had smoothed out. He had started going to work for an hour both morning and afternoon. His appetite had materially increased. Blood pressure 176/100.

19-4-27. Patient was boisterously cheerful. His laughter was irrepressible. He told me that not only his urinary troubles had disappeared, but he felt the joy of life and interest in his work, took walks morning and evening, ate heartily and had gained 7lbs. in weight, although in appearance he looked slimmer and more proportionately built. He confided to me blushingly and with hesitation that he had sexual connection with his wife after 13 years of abstention and felt thirty years younger.

19-7-27. The report of patient's urine was quite normal. The prostatic enlargement had almost disappeared. The man looked and behaved like one between 35 and 40 years of age. His mental and physical capacities were, according to him, those which he had when he was a young man. He had expanded his business, taken over nearly as many estates as he had before, and improved his financial condition

materially. He confided to me that he had sexual connection with his wife twice or thrice a week without any fatigue or undesirable after effects.

19-12-27. He was in the fullest enjoyment of health and had never felt so fit as now.

19-6-28. To quote his own words, he was "still going strong as a result of the operation".

19-12-28. Still felt fit and enjoyed good health and good business.

19-12-29. His first wife having died of pneumonia, he had married again. He had coitus twice a week normally but had no children due to bi-lateral vaso-ligature and vasectomy.

19-12-30. Had an accident, a fall from a precipice while flying a kite at a hill station where he had gone on business. Except for bad setting of Collis's fracture of the left fore-arm, he was quite fit

19-6-31 Still quite fit.

Case 2 6th Feb. 1927, T B. S., army contractor, age 58 Looked about 75-80. Hair of the head and beard spotless white ; heart hypertrophied and dilated, shortness of breath on exertion ; arteries rigid, pipelike ; blood pressure 219 111 ; pulse, 148, running and intermittent ; urine showed traces of albumen and a

few hyaline casts. Had been a widower for 18 years. Had amassed wealth and was anxious to have an issue, all the four children from his late wife being dead.

18-2-27.—Steinach's operation in the right scrotal area performed under local anaesthesia.

27-2-27.—Sutures removed, patient discharged from the clinic. Nothing special to note.

18-6-27.—Patient felt vigorous and healthy. Ate and slept better. Blood pressure 150/90. No shortness of breath on exertion. No albumen or casts in the urine. Looked distinctly younger. His face was smoother and rounder. His walk was elastic. He was very optimistic. He had morning rise but otherwise had noticed no improvement in sexual desire.

18-12-27.—Patient looked and felt better and younger. He was a good patient and would do nothing unless advised by me. He said he was working ten to fifteen hours a day without fatigue, and felt sure he could become father of a child if he married again. He wanted permission to do so.

18-9-28.—Patient felt completely regenerated. He had married a young woman. She was pregnant. He was cheerful and wanted me to be present at the confinement of his wife

and name the child, which he was sure would be a son.

18-11-29.—He brought his little son for me to see. He was proud of it.

18-9-30.—He was better and fitter in mind and body than he could remember being.

18-3-31.—He was still in full enjoyment of health. He was expecting another issue.

Case 3. 3rd March, 1927. M. P., field labourer, age 41. Got crushed under a heavy weight and bruised both his testes, the right one more than the left. They were both swollen and inflamed. This had happened three years ago. He got well after nine months, but found that he had lost all sexual powers and become very fearsome and cowardly whereas before the accident, he was courageous and pugnacious. His wife, being very unhappy, had left him and contracted liaison with another man. He felt wretched and if nothing could be done to restore his virility, he felt he would like to end his life.

Examination showed all his internal organs in normal condition of health, but both testicles were soft and small, the right one about the size of an almond, the left about twice that size. The testicular sense was present in the left, but completely absent in the right. I was

very doubtful of any improvement.

14-3-27.—Vaso-ligature and vasectomy was performed on the right side under local anaesthesia in the scrotal area. He was discharged on 19th March, 1927.

19-4-27.—No subjective or objective change except that testis on the right side was bigger and firmer than on the left side.

19-5-27.—No subjective change, but he had noticed his hair and nails growing faster and aversion from the company of women was less.

19-7-27.- The right testis was almost normal in size and firm. The left had also increased in size but was not quite so firm. He thought no more of suicide, and had morning rise and some sexual desire. He had lost his timidity and cowardliness and knocked down a fellow who talked of the infidelity of his wife to his face.

19-5-28.--He came to my consulting rooms and was so impatient to see me at once without waiting for his turn that he quarrelled with two of my patients and had an altercation with my assistant. I could hardly recognise him when I saw him. He looked a young man of 25, with glossy hair and smooth skin. He told me his wife had returned to him and he had given a good thrashing to his former rival. She was

going to be a mother in a few months' time.

27-6-30.—He looked well and owing to increased capacity for work, he had become foreman of field labourers and was earning a good salary. He was hoping to be the father of "a girl this time".

19-1-31.—He forced himself into my presence and said that I had given back to him his manhood, his courage, his wife, and two children.

Case I. March 9th, 1927. S. M. A., merchant, age 68. A widower. Second wife died 11 years ago. Had two sons from his two wives who were his partners in business, and having quarrelled with him, had separated. He wished to marry again and have an issue, so that his two rebellious sons might not take possession of his property.

Examination showed all organs of the body to be normal His genital organs also gave normal reactions but he said since the death of his second wife, he had not even thought of a woman or of marriage and had no sexual desire. Only recently, after a quarrel with the children and the division of his property and business, he had thought of marrying again, but he found himself quite incapable. I told him that there was nothing wrong with him, as the

examination revealed him to be physically fit. It was probably his over-anxiety that made him feel impotent. Three months tonic treatment proved unhelpful.

7-7-27.—He followed me to the hill station where I had gone for a holiday and begged me to do something for him. I performed right-sided vaso-ligature and vasectomy by the scrotal route.

13-7-27.—Sutures removed. Patient left for the plains. Nothing of note reported by him.

1-10-28.—A month and half after the operation he felt such continuous sexual exaltation and desire that he was obliged to select a partner and marry her. His newly wedded wife had missed two periods and thought she was pregnant.

21-9-29.—He was father of a son, and moreover had become so industrious and so successful in business that he had opened two new branches in provincial towns, and was now organising branches in twelve new centres. His rebellious sons were impressed by the business capacity of their father and had begged his forgiveness.

21-9-30.—He came to me with offerings of fruits and flowers and brought his two rebellious

sons with him. They looked more like his brothers than his sons, his appearance had so much improved. He said he was in full possession of his mental and bodily vigour.

6-5-31.--He was as healthy and robust as ever and had now altogether three children. He had established all the branches of his business which he had planned and they were all working satisfactorily. He had become quite a prominent business man.

Case 5. 17th Feb. 1927. P.L., jeweller, age 57. Looked pale, thin, highly nervous, fidgety, spoke hesitatingly, altered or retracted statements after making them, did not know his own mind, contradicted himself several times within a few minutes, had bad memory for facts and figures, did not remember names even of his brothers and sisters or his own children, had failed in business owing to increasing mental incapacity. He looked prematurely old. He told me that in the early years of married life he over-indulged himself sexually and wrecked his health; that for the last 14 years he had been using all sorts of medicines to improve his waning sexual powers but nothing had done him any good. He had come to me as a last resort, and if it failed, he was sure to commit suicide.

His pulse was of low tension, jumpy, and fast

—120 when excited and 100 when calm. His heart had no organic disease but was weak ; blood pressure, 105/71. No other disease except highly exaggerated nervous reflexes and fine tremors of the hands. The blood showed marked anaemia, the urine was full of phosphates. The two genital glands were small, soft, flabby, and almost without any testicular sensation on pressure. It was doubtful whether, in a case of this kind, rejuvenation would prove beneficial, but on explaining my doubts, he pressed me to give him the chance, and I agreed to do vasectomy and vaso-ligature.

18-2-27.—Right sided vasectomy and vaso-ligature were performed by local anaesthesia through the scrotal route.

22-2-27.—Patient discharged after removal of sutures. He told me that from the day following the operation to the time of his discharge, he had suffered from excess of sexual desire and almost continuous erection, but I dismissed it as the result of his keen imagination and auto-suggestion.

9-3-27.—Patient came to report himself without being asked to do so, and repeated the same story which he had related at the time of his discharge, only with greater vividness of detail, so that I felt obliged to take it more seri-

ously than on the previous occasion. I cross-examined his wife; she confirmed the statement, but whether it was because of her natural modesty or because her observations were purely objective, the story lost much in vividness and colour. I sent him back with strict injunctions to practise moderation, if not complete abstinence. His blood pressure was 120/82, and his pulse was 78. The heart beats were more forceful and even when excited his pulse rose only to 84. His reflexes were nearer the normal than before and his skin and facies were improved.

9-9-29. The patient had not taken the trouble to report in spite of repeated reminders, and I had lost all count of him. When he came after two and a half years, I did not recognise him and took him to be a new patient, as he looked quite a young man. When he told me who he was, I was surprised. There was so much change in his face, in his hair, his skin, his bearing, his talk, and even in his mode of expression, that had I not known him before, I should have been disposed to doubt his identity.

5-3-30 Patient said he had now become a partner in the firm of jewellers in which he had started as an employee six months back, as his work and experience in business were considered indispensable by the proprietors. He said his

memory was better than it had been ever before. His powers of detecting minute flaws and varying qualities in precious stones at first sight were amazing. He not only surprised his ex-principals and present partners, but he often surprised himself. His capacity for sustaining work had markedly increased, and potency and libido had returned in full force. He was happy and cheerful, his optimism was infectious, and he was altogether pleased with himself and everybody.

6-6-31.—He was still in full enjoyment of mental and physical health and he had taken a second wife.

ANALYSIS AND DISCUSSION OF CASES

Cases 1 and 4 were two typical cases of physiological senility brought about by old age. In the first, there were symptoms of chronic urinary sepsis due to enlarged prostate ; there was arterio-sclerosis with high blood pressure ; there was loss of energy and general physical and mental deterioration. The patient was treated for enlarged prostate and urinary trouble. He expected nothing but relief of these symptoms. There was, therefore, no question of auto-suggestion here.

In Case 4, there was loss of potentia sexua-

lis and potentia coeundi due to old age, otherwise the patient was well. He desired an issue.

In Case 1, bi-lateral and in Case 4, right-sided vaso-ligature and vasectomy were performed. The results were startling in both cases as regards the return of mental, physical and sexual powers. In the first case the urinary condition was improved, blood pressure decreased ; the patient felt the joy of life, took great interest in his work, expanded his business, gained in weight and had his sexual powers completely restored. He looked and behaved like a younger man This condition was maintained up to 3 years and 4 months, when patient was last examined.

In Case 4, sexual powers were completely restored and the patient married and had three children. There was also great improvement in his appearance, his physical and mental capacities had much improved. He had established many new branches of his business, which were working satisfactorily When examined 3 years and 10 months after the operation, the patient was in full enjoyment of the newly regained mental and physical health.

Both these cases are good illustrations of regeneration due to Steinach's operation.

Cases 2 and 5 are both good examples of

premature senility. Case 2, besides impotence, had hypertrophied and dilated heart, arterio-sclerosis and high blood pressure. He was anxious to have an issue. Case 5 had failed in business, had mentally deteriorated, was neurotic, had feeble heart and low blood pressure. In Case 2, there was great improvement in general health and cardiac symptoms. When last examined 4 years and 1 month after the operation, he was in full enjoyment of health. He had one son and was expecting another issue. In Case 5 there was marked sexual exaltation, which continued for a fortnight after the operation. His general appearance, bearing and nervous conditions had improved to such an extent that it was difficult to recognise him. His technical skill had improved. He had increased capacity for work, and had marked libido and potency. When examined 3 years and 3 months after the operation, he had married.

The former case is a good example of improvement in circulatory diseases besides other conditions, and the latter of noted improvement in neurosis.

Case 3, is an instance of remarkable mental and psychic changes as a result of accidental injury to the testes, their atrophy following the injury; complete loss of vita

sexualis and change in character from courageous manliness to fearsome cowardliness. The chief organs of the body were normal, but testes were small, soft and devoid of sense. Five weeks after operation, no subjective change, but the testis on the operated side was bigger and firmer. Nine weeks after operation, vigorous growth of hair and nails and less aversion from female society. Thirteen weeks after, suicidal thoughts absent. Thirteen months after, assertiveness and pugnacity, two typical characteristics of the male, appeared. He looked younger, had glossy hair, and smooth skin. His wife had returned to him and was pregnant. Three years and three months after, his working capacity and virility had greatly enhanced and his wife was expecting another child. Three years and seven months after, he was in full enjoyment of his powers

Chart giving Analysis of 100 Cases treated by Auto-Regeneration.

	Indications for Regeneration.	Numbers.	Positive Results Duration			Negative Results.	Percentages.	
			1–2 Yrs.	2–3 Yrs.	3–4 Yrs.		Successes.	Failures.
1.	Senility	7	1	2	3	1	85·72%	14·28%
2	Premature Senility	41	17	12	10	2	95·13%	4·87%
3.	Prostatic Hypertrophy.	8	...	...	7	1	87 5%	12·5%
4.	Nervous Diseases.							
i.	Paralysis Agitans.	5	...	...	4	1	80%	20%
ii.	Psychoses and psychoneuroses.	7	...	...	5	2	71·43%	28·57%
5.	Heart and Circulatory Diseases.							
i.	Stenocardia.	2	...	...	1	1	50%	50%
ii.	Cardiac hypertrophy with arterio-sclerosis and high blood pressure.	5	..	..	5	...	100%	...
6	Impotence.	25	12	7	6	...	100%	...

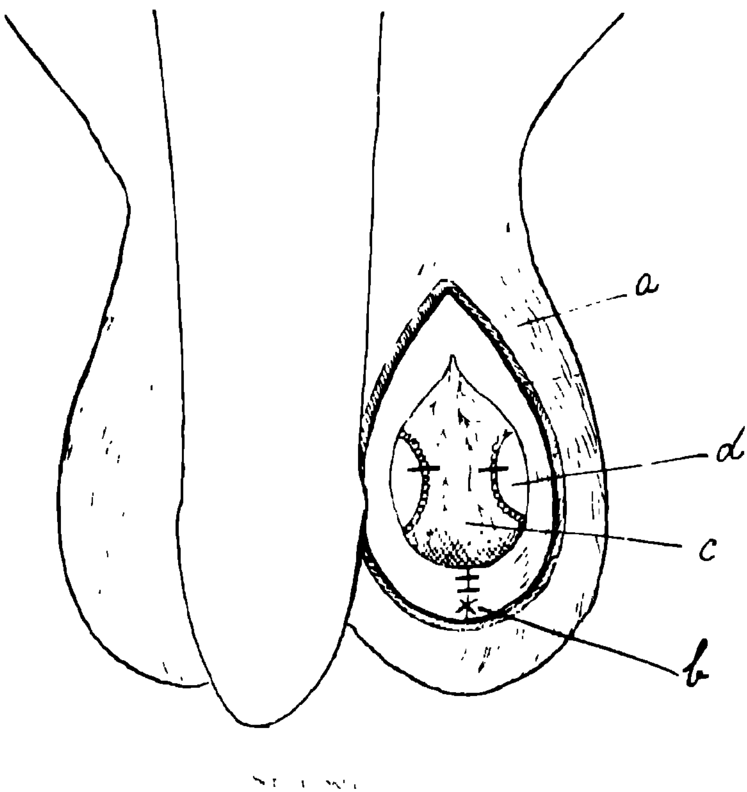
CHAPTER VI

HOMO-REGENERATION BY IMPLANTATION OF HUMAN TESTICULAR GRAFTS

These hundred cases were treated by grafting of human testes. I took special pains to keep in touch with the patients, sometimes with great inconvenience to them, and always with some difficulty. The other re-activation methods were a little different; their total number was much larger. In many cases, contact with the patient was not maintained throughout the period under review, and, therefore, only one hundred cases have been selected out of a much larger number. This special care was taken regarding cases of human grafting because of the many difficulties in securing testes for grafting, and also because of the very small number of such cases recorded by other observers.

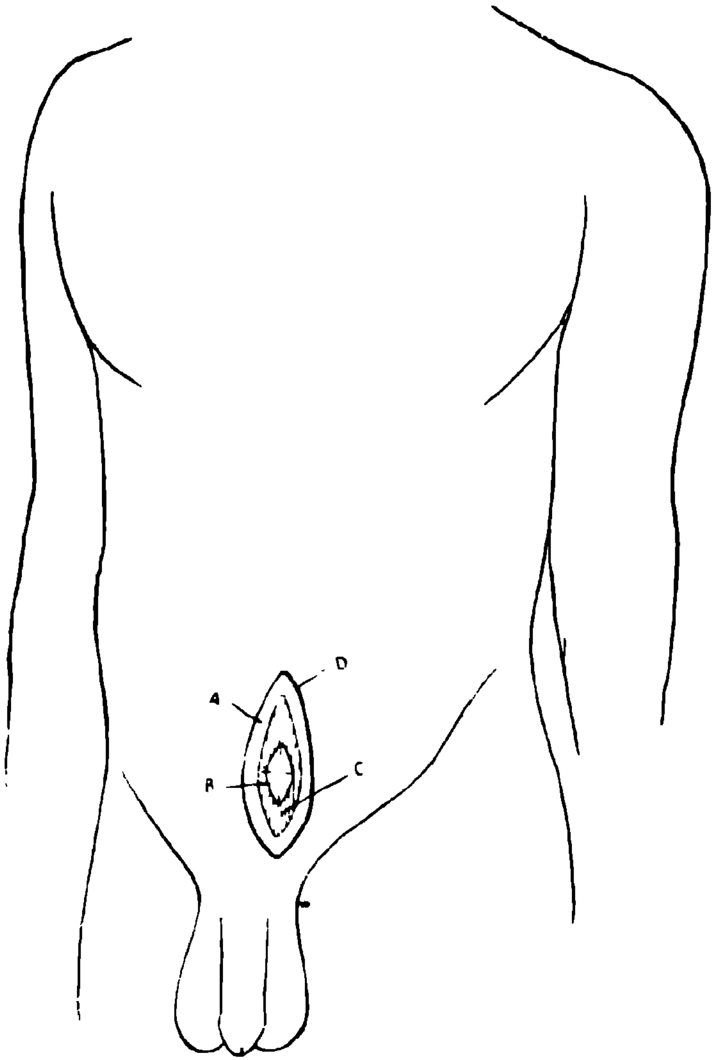
It must be stated that this method has given, comparatively, the best results, but there are great and often insuperable difficulties in obtaining material for graft. Hence the utility and application of this variety of regeneration must be considered strictly limited.

GRAFTING AFTER VORONOFF



[illegible]
[illegible] stitched
[illegible] vaginalis
[illegible]

GRAFTING UNDER THE SHEATH OF RECTUS ABDOMINIS



In a certain number of cases the technique of the operation was identical with Voronoff's ; in others, Lichtenstern's method was adopted. A lateral vertical skin incision on either side of the abdominal wall between the umbilicus and symphisis pubis, an inch to an inch and a half in length, was found sufficient. After going through the skin, sub-cutaneous tissue and fascia covering the muscle, the muscle fibres were exposed and slightly scarified, and the graft was stitched on to the rectus abdominis muscle with the glandular surface next to the muscle and the tunica outside. Four sutures were applied, one each on top and bottom, and one on either side. The fascia, subcutaneous tissue, and the skin were then sutured with fine silk, simple aseptic dressings were applied and the patient put to bed. The skin sutures were generally removed after a week or ten days and the patient discharged.

I have had few cases of stitch suppuration. All these cases occurred in scrotal grafting, none in abdominal grafting. I have had no case of the grafts not taking on, only one being partially extruded from the wound. It generally takes from three to nine or ten weeks for the grafts to form attachments and have new blood vessels running into them. In a very large

proportion of cases, transient mental and sexual excitement is reported from about 24 to 72 hours after the graft. I have always underrated these subjective symptoms, putting them down to autosuggestion, but they are so constant and invariable in a large variety of dispositions, that I have now come to regard them as not being entirely psychic, but due to absorption of hormone from the raw surface of the graft through the scarified surface of the area on which the graft is placed. These subjective symptoms are, however, almost invariably transient, lasting from 3-10 days. In a large number of cases they lead to disappointment when they disappear.

FIVE ILLUSTRATIVE CASES

Case I. 9th March, 1927. T. N. S., age 32. Tall, well-proportioned, sporting landowner. Five years ago he got infective parotitis (mumps), on both sides, with fever and fixity of jaw, along with bi-lateral orchitis. He was bed-ridden altogether for 9 weeks, but after the inflammation of the parotids and testicles had subsided, he found himself completely impotent. He had been under continuous treatment of Vaids, Hakims and western physicians, without any avail. He had given up all hopes, but having heard about the operation for re-

gaining potency from a patient of mine, he came to me. He had a young and beautiful wife, he was himself physically and mentally in the best of health, but his sexual power had completely gone since his illness. He was anxious to have an heir to his vast and rich estates.

Careful examination showed all his organs to be perfectly healthy. Height 5 ft. 11½ inches ; weight 13 stones ; heart and lungs, perfect ; blood pressure, 125/81 ; pulse, 74 ; abdominal organs, nothing to note ; urine, normal ; testes, both atrophied, soft, and devoid of any sensations ; the right one of the size of two peas, the left one, a small almond ; no thickening of the cord, and no glands in the groin. No history of syphilis or gonorrhœa. Wassermann reaction negative. I told him that his was the worst case I had so far come across, and that I could give him little hope. Steinach's operation would be futile as there was hardly any testicular tissue left on either side. I, therefore, told him that an operation of grafting would be the proper thing in his case, and the best graft would be a human testicle, which was not easy to secure. He, however, promised to secure a healthy male adult willing to contribute one of his testes. I then told him of crypt orchic subjects, and after a diligent search he secured two

young men of 23 and 25, perfectly healthy and robust, one of them quite normal and the other with partially descended right testis. After a thorough examination to exclude syphilis, gonorrhœa and tuberculosis in these donors, I selected one with the partially descended testicle as the donor.

9-6-27. After giving general anaesthesia to the donor, and having the receiver also ready on an adjoining table for immediate grafting, I removed the partially descended testicle and grafted, under local anaesthesia, four grafts consisting of a quarter of the testes, the gland substance having been sliced to leave it almost of a uniform thickness of about a third of an inch; the grafts were sewn by means of four silk sutures to the scarified surface of rectus abdominis muscles on either side, deep to the fasciae, on a level with midpoint between the umbilicus and symphisis pubis, suturing with silk the fasciae and skin over the graft. Patient discharged 10 days after the operation after the skin sutures were removed.

1-7-27. Patient came despondent and dejected, as he had noticed no change. The area of graft was completely healthy without sign of any congestion or inflammation. The two grafts on either side could be felt elastic and of

different consistency from the surrounding muscles. They were slightly tender to touch.

1-8-27. Patient came with great difficulty, as no good had accrued from the operation in which he had centred all his hopes, but careful examination revealed the two testicular nodules in the scrotum, if anything slightly bigger and firmer.

2-10-27. Patient did not report himself, but as I had been called to see a near relation of his in the town of his residence, I examined him with some reluctance on his part, and found all the four grafts still intact and his two testes slightly bigger than last time, and of elastic consistency. He felt a little pain on pressure.

25-12-27. Patient reported himself of his own accord and without making any previous appointment. He said he was saved, as he had decided to commit suicide if he did not regain his powers. A fortnight back, he said, he woke up at 4 o'clock in the morning and found he had had a wet dream. At first he did not understand it, as during the last six years he had almost forgotten that there was such a thing, but on realising what it was, he shouted with joy, jumped out of bed and shook his wife out of her sleep and told her what had happened. She said it was a miracle. Ever since he has felt a differ-

ent man. He had regained his self-confidence and self-respect. He did not hide himself from men ; he no more thought himself a coward as he had done lately, but felt "the Rajput blood coursing hotly in my veins". Since this incident, he had noticed erections every morning and an intense desire for coitus, but he had restrained himself as he was afraid he might lose his powers if he made a mistake and indulged in his desire without my permission.

Examination revealed the grafts still palpable but smaller and harder. His own testes, however, had become almost of the normal size and of hard consistency, and tender on pressure.

25-6-28. The patient felt stronger in body and mind, could work almost continuously without tiring. He had gone over all the accounts of his estate for the last six years, which had been completely neglected. He had filed about fifty cases for arrears of rent. He hunted and exercised himself by riding and Indian gymnastics, and his domestic relations with his wife were as they had been when they were newly married. He thought his wife was pregnant. Examination of grafts showed four small nodules the size of peas, but both his testes were large, firm, tense and tender on pressure.

23-6-29. The patient was fit as ever. He

was overjoyed at having a son and heir whom he named after me. The grafts were hardly palpable but the testes were normal.

17-9-30. Patient came to be examined. He was fit and enjoying the fruits of manhood as before. The graft nodules had completely disappeared. His testes were quite normal.

9-11-31. Patient was strong, robust, and in the enjoyment of perfect health. He was the father of a second son. The testes were quite normal.

Case 2. 21st March, 1927. R. G. H., age 29. Patient had tubercular orchitis and epididymitis of the right side twelve years back. He had three operations, as the result of which the testis along with portion of the cord was removed. Four years back, the left side was similarly affected and in spite of every effort to save the testicle, it had to be sacrificed to save his life. For the last three years, after prolonged anti-tubercular treatment, he had been free from any urinary trouble. He had had no fever and had put on weight, and looked healthy and robust. Careful examination of his lungs, abdominal organs, bladder, glands, throat and nose revealed no tubercular foci. Examination of his blood also was negative. He was anxious to start his practice as a lawyer and get

settled down in life. He also wanted to marry and to have children, if possible. I told him that the latter was utterly impossible as double castration had made him completely sterile, but the return of some sexual power was not improbable, though he must understand that his future partner in life might be disappointed at not having children. He told me he would return after considering the matter.

28-3-27. He came to me with his father and the father of the young lady he proposed to marry. I explained the situation to them both. He decided to have grafting of human testes on to him. Fortunately for him, I had an operation for hernia with an incompletely descended testis, but I explained to him the uncertainty of the benefits that might accrue. Further, if and when he regained his sexual powers, he must be very careful and on no account over-indulge himself, for it would be bad for his general health, he being a tubercular subject, as well as for his sexual powers, which would only be transitory, as both his own testicles had been removed by operation.

31-3-27. Implantation of four grafts was done, two on either side under the sheaths of rectus abdominis muscles, the sites having been previously scarified.

7-4-27. Stitches removed. Patient reported excitement and great sexual exaltation. Patient discharged.

14-5-27. Patient felt infinitely better in himself than he had done for years. His appetite had increased. He had gained 7 lbs. in weight, but curiously he looked slimmer than before. He had been working with his father, who was a renowned lawyer, for six and eight hours a day without any signs of fatigue, and had produced a very good impression on the Bench and the Bar. He had been getting morning erections almost daily, to his surprise and joy, and he had several wet dreams. When the phenomenon was explained to him that the fluid discharged contained no sperm cells, and hence conception was not possible, he was more mystified than ever, but quite pleased and satisfied and wanted permission to marry. The grafts were quite good, except the right lower, which was slightly inflamed and tender. On being questioned, he said he had involuntarily got into the habit of putting his right hand on this spot and feeling it constantly, moving it about and playing with it. He was warned against this habit.

3-11-28. Patient said that in spite of reminders from my assistants and his desire to

report, he felt so well mentally and bodily, including his sexual life, that he did not think it worth while to bother me. He said that now he and his wife knew and understood each other, he had been able to explain their inability to have any children quite satisfactorily to her. They were both happy and contented. He usually performed the sexual act once a week, although if permitted, he would have liked to do it oftener.

In his professional work he had done remarkably well, considering that he was a junior. His father, who had lost all hopes about him, owing to the serious state of his health, was now very happy, and hoped he would be able to retire in a few years' time, leaving his son in his place.

13-2-30 The grafts were all intact and curiously they did not seem to have shrunk in size or become hard and indurated. Patient said he was so bound up in his work that he had almost forgotten he was ever seriously ill or had such a terrible physical disability. He had got on very rapidly in his profession. His father even left some of the most important and difficult cases for him to argue His sexual life was perfectly contented and happy He was rather glad he was not encumbered with children. He

was fonder of his wife and she of him than if they had children.

1-3-31. Patient reported himself to be in the fullest enjoyment of health and happiness. The grafts were still palpable, their outline being well defined but slightly smaller than before.

Case 3. 2nd April, 1927. M.H.A., schoolmaster, age 38. Patient had gonorrhœa ten years back, with bi-lateral orchitis and epididymitis. He had also cystitis and right-sided pyelitis. Prolonged treatment lasting over two years ultimately cured him of gonorrhœa and its complications, but he found that he had lost all potency and had not the slightest desire for his wife's company. For the last seven years he found not only loss of sexual power, but a curious change in his character. He had, before his illness, a very retentive memory ; now it was difficult for him to remember anything even with the help of notes. Formerly he had a command of language, now he found himself short of words and expressions. At one time athletic, muscular and manly, now he was emaciated, weak and effeminate. Before this he had been very witty and entertaining ; now it was difficult for him to grasp the point in a joke and he had become melancholy and morose.

Examination revealed his heart to have systolic murmur at the apex and accentuation of the aortic sound. There was also some hypertrophy and dilatation of the heart. The lungs were quite sound. The abdominal viscera were normal. Blood examination revealed 3,550,000 R.B.C.'s and 7,850 W.B.C.'s. Wassermann reaction negative. Examination of urine showed a few pus cells and a few vesical and urethral epitheleal cells and a trace of albumen. Both the testes were small and nodular, with thickened epididymi. Both the cords were thickened like whipcord. The prostate was slightly enlarged and tender on pressure. He had not had any libido or wet dreams for the last nine years.

It was clearly a case of post-gonorrhœal orchitis with epididymitis, with almost complete atrophy of the genital glands and probably occlusion of the spermatic ducts. I advised him to secure, if possible, a healthy young adult man as a donor, and to have grafting operation. I, however, warned him of the uncertainty of the result, and told him that even if some benefit accrued, it might be only temporary.

16-4-27 Patient brought his brother-in-law who had an imperfectly descended testis and right-inguinal hernia. The donor was perfectly healthy, 27 years of age, free from any

gonorrhœal, tubercular, or syphilitic infections. He was father of three healthy children. The donor was operated for his inguinal hernia and the imperfectly descended testis was removed. It was rather small (the size of an almond), and soft. I had, therefore, some doubts as to its proving efficacious. However, it was implanted under local anaesthesia, in four slices on to the patient's rectus abdominis muscles.

28-4-27. Sutures were removed and patient was discharged. He reported great sexual excitement during the last three days but no erections nor any seminal discharge. It was thought to be due to auto-suggestion.

28-6-27. Patient reported that he had been feeling much better mentally and physically than he had done for years. His work at school had ceased to be a burden and he had commenced taking some interest outside school hours, but there was no change in his sexual life. Examination revealed the grafts to be intact and if anything a little larger than on his discharge. The two testicles appeared less nodular and probably slightly larger.

28-8-27. Patient was discontented and unhappy about the failure of the operation in improving his sexual powers, but he had regained all his mental and physical powers. His work

was a pleasure to him and he had started dumbbell and walking exercises which he had not done for the last ten years. Examination revealed the grafts intact and about the same size and consistency as on previous examination. Patient had gained more than 21lbs. in weight; the right testis was the same as last time, but the left was about the size of a large almond and the nodules were impalpable.

10-12-27. Patient was able to see me after writing several times and sending me two telegrams. He was impatient to come to me. I had guessed the reason and was prepared for it, but did not expect to see such a transformed young man, looking not more than 22 to 25. He told me that a week or ten days after his return home from his last visit, he suddenly found himself being attracted by the beauty of his young wife and on going to her he discovered to his great surprise that he was perfectly able to perform the sexual act with infinite satisfaction. Since then he had been writing and wiring to me for consultation as he was happy but fearful lest he might do something to lose his virility. Examination revealed all the four grafts intact, but slightly smaller than before His left testis had assumed normal proportions and normal sensations, and even the right was bigger than

before. I warned him against the abuse of his regained sexual powers.

12-12-29. Patient did not respond to several communications from me and my assistants. He visited Delhi in connection with an educational gathering and came to see me during his stay. I found the grafts still palpable, the right upper and the left lower being twice the size of the other two. Both his testes were normal in size and he had become the father of a child in the interval. He was considered so efficient in his work that he had been promoted to a high post in a college in his provincial capital. He was highly pleased with the results.

8-12-31. Patient was in the enjoyment of good health, mental and physical. His sexual life was quite normal. The grafts had all but disappeared and the testes were normal.

Case 4. Q. A. K., timber merchant, age 58. Looked much older than his age. His hair was white. He had a stoop and came leaning on a stick. His only son, 37 years of age, died last summer of enteric fever. He was anxious to have a son. Examination revealed that he had a hypertrophied and dilated heart, but with perfect compensation. His arteries were markedly thickened. His pulse was 118 after exercise and 90 at rest, but quite regular. He

suffered from some shortness of breath on exertion. All other organs of the body were found normal. Examination of his genital organs revealed one impartially descended testis palpable at the right external inguinal ring. It was small, the size of a cherry, and very soft, devoid of all sensation. The left testis was in the sac but was also small, soft, and with hardly any sensation. I had considerable difficulty in deciding whether Steinach's operation or grafting would be suitable for him. I decided on the latter. He secured a donor, a young man of 25, perfectly healthy and free from any disease.

7-9-28. Implantation was done under local anaesthesia, two strips of the graft on the right rectus abdominis and two on the left scrotum, according to Voronoff's technique.

18-9-28. Patient was discharged after removal of sutures. He did not report any subjective or objective symptoms.

3-3-29. Patient, in spite of repeated reminders, did not come to report and when he came nobody could recognise him to be the same man. He had no stick, no stoop ; his hair, though white, was thick and glossy, all the wrinkles on his face and forehead had disappeared ; his skin had a very healthy, well-nourished appearance ; his walk was firm and

elastic, his feeble piping voice had changed to a deep tone.

Examination showed blood pressure, 141/98 ; pulse on exertion 80, when resting, 68 ; the grafts, both over the right rectus and the left testis were healthy and intact, and both the testes, the impartially descended one and the one in the scrotal sac, had markedly enlarged in size and had become firmer. The testicular sensations had completely returned. The patient was getting morning erections for the last four months and had wet dreams almost once a week. He desired permission to marry.

5-5-30. Patient came accompanied by his young wife with a little infant son in her arms. The old man was so overcome with emotion that he could not say a word and had to go out and return after an hour, when he felt able to speak. He had brought fruit and flower offerings and little trinkets for me and my assistants who had helped at the operation.

15-5-31. The father came again with his son and said his wife could not come because she was pregnant. He said he had increased his business and had taken a very big army contract.

Case 5. 11th September, 1928. L. D. N., banker, age 71. Well-nourished and well-preserved. His sons had quarrelled with him and

had deprived him of all his property and business as they said he was too old and of unsound mind to handle business. He was very angry with them and wanted to teach them a lesson. He had married again but had no issue, as he found coitus imperfect.

Examination revealed his heart to be normal but weak ; his arteries less rigid than one would expect in a man of his age. Pulse was 92 at rest, 116 after exercise, quite regular. Blood pressure, 198/102. Lungs showed chronic bronchitis. Liver and spleen enlarged and hard. He had inguinal hernia on both sides, descending into the scrotal sac. Testes small, size of an almond, soft, with slight sensation. He was free from tubercular, syphilitic and gonorrhœal infections. Blood showed slight anæmia. Urine quite normal.

As he suffered from double inguinal hernia, the question was whether his testicular wasting might not be partially due to age and partially due to pressure of hernial contents, and whether it would not be necessary and advisable to treat his hernia first and then treat him for his senility.

9-10-28. Patient operated for hernia on both sides under lumbar analgesia.

30-10-28. Patient discharged but warned

against any strain being placed on the newly healed wound and also because, owing to age, his abdominal muscles were weak and might easily give way. He was asked to return every month to report, and to search a suitable donor for testicular grafting.

10-12-28. Patient had four grafts implanted on to the two testes by Voronoff's technique, the donor having been previously examined to make certain of his freedom from tuberculosis, syphilis and gonorrhœa.

7-1-29. Sutures removed. Patient discharged. He reported great sexual exaltation and excitement from 24 hours after the operation to the time of his discharge.

7-2-29. Patient felt well. Said he felt younger. Had beaten both his sons in feats of memory. He had made most profitable business transactions in spite of the opposition of his sons and proved to them that he was a better business man than they. He spent eight to ten hours at his business and felt none the worse for it. As regards his sexual life, he had strong desire and had also erections, but he had abstained from connection with his wife until permitted. Pulse 78/66. Blood pressure, 159/100. The grafts were all intact and the two testes were now bigger, about three or four

times the size of the graft, whereas before they felt smaller than the two grafts.

7-9-30. Except for his grey hair, he looked younger and felt better than he had felt for the last 40 years. He had got rid of his cough entirely. He had put on 14lbs. in weight. His appetite was good. His wife was pregnant.

7-5-31. Patient was pleased but discontented as he had a girl and not a son. However, his two rebellious sons were now completely tamed, and he was unchallenged master of his own house. His domestic life was perfectly satisfactory.

ANALYSIS AND DISCUSSION OF CASES

Of the five illustrative cases, Cases 1 and 3 were those of atrophy, almost complete, following infective parotitis (mumps) and gonorrhœa, respectively. Case 2 was that of bi-lateral excision of the testes following tubercular infection. All the three cases may be taken as instances of the best results of regeneration following grafting. But there are clear differences owing to complete absence of the testes in Case 2, making the patient sterile, although in the fullest enjoyment of mental, physical and sexual powers, while in the other two cases, the patients regained their mental, moral and phy-

HOMO REGENERATION—HUMAN TESTICULAR GRAFT



Case X

Over two years after grafting

sical powers and full reproductive capacity, with the formation of new testicular glandular tissue, both excretory and incretory.

Case 4 is a typical instance of almost startling results in cases of premature senility. The patient not only improved considerably in his sexual ability, but his mental and physical conditions were improved almost beyond recognition.

Case 5 is a case of senility in which there is a very obvious and marked improvement in the patient's mental, physical and sexual condition. The change in his circulatory condition is very notable.

One very marked improvement common to all these cases has been in connection with the circulation to the skin and integuments. The hair of the head and the skin of the face improved greatly in all cases, giving a much younger appearance than the actual age of the patients.

Chart giving Analysis of 100 Cases of Homo-Regeneration

	Indications for Regeneration.	Numbers.	Positive Results. Duration. 1–2 Yrs.	2–3 Yrs.	3–4 Yrs.	Negative Results.	Percentages. Successes.	Failures.
1.	Senility ...	6	3	1	...	2	66·6 %	33·3 %
2.	Premature Senility ...	38	14	12	9	3	92·11 %	7·89 %
3.	Testicular							
	i. Anorchidia following surgical excision of tubercular testes.	3	...	1	1	1	66·6 %	33·3 %
	ii. Atrophy following accidents, mumps or gonorrhœa.	8	3	2	2	1	87·5 %	12·5 %
4.	Nervous Diseases.							
	i. Paralysis Agitans.	2	..	...	1	1	50 %	50 %
	ii. Psychoses and psycho neuroses.	3	1	2	...	...	100 %	...
5.	Heart and Circulatory Diseases.							
	i. Stenocardia.	3	...	2	1	...	100 %	...
	ii. Cardiac hypertrophy with arterio-sclerosis and high blood pressure.	22	7	7	6	2	90·91 %	9·09 %
6.	Impotence. ..	55	15	10	21	9	83·64 %	16·36 %

CHAPTER VII

HOMEO-REGENERATION BY SIMIAN GRAFTS

In India two varieties of monkey are commonly found. One is the Macacus Rhesus or the Bengal Macaque, having a thick-set body, red face, red callosities and buttocks, and short stumpy, tail. They are very mischievous and infest houses, gardens and fields. These live in troops of considerable size in jungles and often in rocky places. The other variety, which is more common, is the Pitheeus Entellus or Langur, with black face, long, lithe body, and very long and powerful tail. They are very agile, active, and are found generally on trees near villages as well as in jungles. They are frequently seen on the ground searching for food, especially near cultivated areas, around tanks, and among trees on the river banks. Owing to the sanctity attached to these animals, it is not easy to use them for grafting purposes without rousing some antagonism among the people. The orang-outang and the chimpanzee are not found in India. The chief difficulty was en-

countered in getting males of ripe age, sexually mature, but not old. Among many tests for securing a young adult male, the surest is the colour of the teeth, especially the canines, as well as receding or otherwise of the gums. In young adults, the gums are firm and only a third of the tooth is exposed ; roughly speaking, the other two-thirds is covered by the gum. The colour of the tooth is either white or yellow. In old monkeys, the gums recede and expose more than a third of the tooth, while the colour is either dark yellow or brown.

The easiest way to see their teeth and gums without risk or injury is to give them something to eat, *e.g.*, a banana, eating one yourself while making faces at them and exposing your own teeth and gums, which they at once imitate and thus expose them for inspection.

There is considerable difficulty in chloroforming these animals before removing the testes for graft. They are powerful animals and will not sit still ; and even if the movements of their head and body are controlled by strapping, they will not inhale the anæsthetic. A very ingenious cage has been invented by Voronoff for this purpose, but it is expensive, cumbersome, and gets easily broken. The best way, therefore, is to give them an injection of mor-

phia or morphine scopalamine, fifteen to twenty minutes before administration of the general anaesthetic. They are then easily controlled and get under the effects of general anaesthesia without trouble. It facilitates work to have the recipient of the graft ready on an adjacent table so that the graft removed from the donor is at once grafted on the recipient. After shaving off the skin of both donor and host, the parts are sterilised by painting the skin with 2% spirit solution of Iodine, followed by rectified spirit. I never use any antiseptic lotions during the operation but use sterile normal saline solution and have never had any trouble with the implants.

The technique of the operation is the same as that given for human testicular grafting.

FIVE ILLUSTRATIVE CASES

Case I. 13th February, 1927. M. H , talukdar, age 58. Looked much older. Bad pyorrhœa; eleven teeth extracted. Tongue thickly furred, breath heavy ; suffered from indigestion and chronic constipation. Skin of face and body sallow, wrinkled, and mottled. Head, bald in centre ; beard, thin and scraggy ; arteries thickened ; both temporal arteries tortuous and stood out prominently on either side

Pulse, 68 at rest, 100 after exertion, regular but weak; heart dilated, sounds feeble, aortic accentuation; blood pressure, 196/110; chronic bronchitis; stomach dilated; intestines loaded with fæcal matter and distended with gas. Liver, slightly enlarged and tender in the gall bladder area; spleen, slightly enlarged. Blood showed 3,2188,527 R.B.C.'s and 9,150 W.B.C.'s; Hæmoglobin index, 69%. Urine, loaded with oxalates and urates, indican and trace of albumen. No casts.

For the last five years he had complete loss of sexual powers and loss of mental and physical health. He found it an ordeal even to talk to his friends and relations. As for doing any work in connection with his property, it was impossible. He found himself sitting and moping the whole day long. He had lost his memory and had no interest in anything. Even for food he had to be reminded before he took it. There was no history of tuberculosis, syphilis or gonorrhœa, and examination proved absence of any of these infections The examination of genital organs revealed atrophy and softening of both testes and complete absence of testicular sensation and cremasteric reflexes.

26-2-27. Patient had four quarter slices of simian grafts implanted by Voronoff's tech-

nique, two on either side of his testes, under local anaesthesia.

4-3-27. Stitches removed. Patient had not reported any subjective symptoms.

31-3-27. The grafts were intact and showed no congestion, inflammation or pain. Patient had noticed no change, mental, physical or sexual. He was very disappointed and cynical.

18-4-27. Patient looked cheerful. He had been eating and sleeping better. Bowels had been moving regularly. Gained 9¾lbs. in weight since the operation. He had noticed some sexual desire and erections in the morning.

17-5-27. Patient looked cheerful. His facial expression had much improved. The skin looked healthier, pigmentation was less marked, and the wrinkles were much obliterated. The temporal arteries were not noticeable. He said he now needed his friends, and enjoyed their company. He had commenced taking an interest in his estate. He became cross if food was delayed and had started going out for drives morning and evening. Pulse, 78 ; blood pressure, 152/98 ; anæmia less marked ; R.B.C.'s, over 4,000,000. Urine still contained oxalates and urates, but fewer ; albumen was absent, also indican. The grafts were intact ; both the testes were bigger and firmer.

The testicular sensation had returned and cremasteric reflexes were brisk.

12-10-28. Patient looked quite changed. His bald head was covered with hair. His beard was trimmed, thick and glossy ; his face was rounded, skin sleek, with few wrinkles and free from pigmentation. He felt better in mind and body than he had done for the last 20 years or more. He had restarted his sexual life. He had been warned to be cautious but somehow, in spite of his intentions, he could not abstain.

11-12-29. The grafts were small and just palpable. The testes were large, firm, and hyper-sensitive. He was living a normal sexual life. His mental and physical conditions were, according to him, those of a young man. He was carrying on his work efficiently and living a full social existence. He was pleased with himself and everyone.

5-12-30. The grafts could not be felt but testes were still large, firm and sensitive, though somewhat smaller than the last time. He was in full possession of his mental, physical and sexual powers.

6-6-31. Patient visited me. He was still in the fullest enjoyment of all his faculties. The testes were smaller than before but firm, and

HOMEO REGENERATION SIMIAN
GRAFT



Case 1

[illegible] eighteen months after grafting

sensitive. He had noticed no appreciable decline in his mental, physical or sexual powers.

Case 2. 1st March, 1927. B. S., Jat peasant, age 61. Tall, well-built, full-blooded, active, but for the last twelve years, owing to repeated shocks due to the death of three of his sons in the war, and the remaining two from illnesses, he had lost interest in life. Height, 6ft. 2 ; weight, 20 stones ; pulse, 85 ; blood pressure, 188/109 ; arteries, thick and tortuous. He had been a meat-eater and given to heavy drinking all his life. Heart hypertrophied, booming sound at apex ; marked accentuation of pulmonary and aortic sounds. Liver enlarged and somewhat indurated. Urine contained albumen and a few casts. Genital organ showed marked atrophy and softening of testes ; absence of testicular sensation and cremasteric reflexes. He was a widower. He wanted to marry and to leave a son to continue his name and to inherit his property.

7-3-27. Simian grafts in four slices were implanted under the sheath of the recti muscles.

14-3-27. Stitches removed. Grafts intact and without any congestion or inflammation. The patient reported exaltation of mind and accession of energy 48 hours following the operation. My assistant reported that the patient

was pugnacious, left his bed, had quarrelled with and knocked down other patients. There was, however, no sexual excitement.

11-4-27. Patient came to my house at night without any appointment, forced himself into the room where I was entertaining some friends, and in his excitement, lifted me bodily. He told me he felt stronger and younger than when he was a young man, and that unless I gave him permission to marry, the sin of adultery would fall on my shoulders. I gave him permission and asked him to return two months later to be re-examined.

11-6-27. Patient was married, and in spite of warning, had indulged in sexual excess. He felt fit in body and mind. He was carrying on a transaction for the purchase of an adjacent plot of land twenty times the size of his own holding, and felt confident he would produce better crops than his neighbour. The grafts were palpable ; both his testes had enlarged and had regained their sensations ; the cremasteric reflexes were slightly exaggerated I warned him against sexual excess. There was danger of his heart and vascular system giving in under the strain.

19-7-28. Patient looked younger and slimmer ; he was less boisterous. His wife had

a son. He had been successful in his new land undertaking and had made money.

29-9-29. Since his last examination over a year ago, he had kept good health except for three months, due to head injuries received in a fight with his neighbour over the newly purchased plot of land. His power of sustained work in the field was amazing. His sexual life was comparable to his early youth, but he had been careful owing to my warning. Sometimes, however, there were several sexual congresses in one night.

11-8-30. He had been keeping excellent health during the interval. The grafts were still palpable, although they had shrunk to about half the size of the original. Both his testes were large and firm. His pulse was 70 ; arteries did not feel thick ; his blood pressure was 130/88. He had a severe attack of dysentery from which he had not yet completely recovered.

3-10-31. The grafts were small, the size of cherries, but still intact. The testes were quite normal. His pulse was 72 ; blood pressure 141/91. He kept excellent health and had a daughter.

Case 3. R. J. S., landed proprietor, age 57. Patient had syphilis and gonorrhœa 30 years

ago. He was treated for over three years, and was cured. He had never any urinary or skin trouble until four years ago, when he began to get rashes over his body, which gradually spread in spite of treatment, and now hardly any part of his body was free from it. For the last ten years, *i.e.*, a year after his second marriage, he felt himself growing weaker in body and mind, but particularly he felt a great falling off in vita sexualis. Hunting and outdoor games of which he was very fond, tired him quickly and he was obliged to give them up. The work of his estate, which required supervision and account keeping, had been steadily neglected by him as he found it distasteful.

The patient was a tall shrunken up old man, quite grey. The skin of face and body, parchment like, wrinkled and pigmented, covered with purple coloured rashes with silvery scales (psoriasis) all over the body. He had early signs of paralysis agitans, with tremors of hands and shaking of the head. Radial arteries, thickened and tortuous; pulse, 86, blood pressure, 205/116; heart, hypertrophied and dilated; compensation complete; accentuation of aortic and pulmonary sounds. Blood showed marked anæmia and also marked leucocytosis. Wassermann reaction weakly positive. Urine

showed some pus, bladder and urethral epitheleal cells and a few casts; a trace of albumen also present. Lungs, nothing to note. Liver, enlarged. He used to drink heavily up to the age of 45, now he drank one peg of brandy before lunch and before dinner. Examination of nervous system showed highly exaggerated reflexes. The genital organs showed pronounced shrinkage and wasting. The organ of generation was smaller than normal, the corpora cavernosa much atrophied. The testes were the size of two peas, soft, and with hardly any sensation, but owing to exaggerated cremasteric reflexes, were found at the root of the scrotum and not hanging in the sac.

5-3-27. Simian testicular grafts in four thin slices were made over the two recti muscles under local anæsthesia.

13-3-27. Stitches removed. Patient had anaphylactic reaction ; fever between 102 and 103.5 ; pulse 120 ; some dyspnœa and slight cyanosis of the face and hands 24 hours after the operation, which passed off on treatment within 48 hours. The grafts were quite healthy but slightly more tender than usual. For the last four days patient had reported great mental and sexual exaltation and almost continuous erections.

14-4-27. He reported that during the interval he had been more cheerful than during the last fifteen or twenty years. At times he had been so boisterous that his wife was afraid he was losing his mind. He had also sexual desire but had restrained himself. He had noticed that the constant shaking of the head had ceased even when under the stress of emotion, and his hands were steadier. There was change in his handwriting after the operation. The grafts were intact and not so tender as before. The testes still felt small and perched up at the roots of the scrotal sacs, but the outstanding fact was complete disappearance of rash from his body during this interval. There was nothing left of it except slight depression and some congestion on the spots where the scaly rashes were situated on different parts of the body.

3-1-28. There was a great change in his appearance; he was hardly recognisable. He had a pink face, with glossy skin almost without wrinkles and without pigmentation. He had a nice head of hair and thick moustache. He felt as if back in his early thirties regarding his mental, physical and sexual powers. He had got rid of his tremors, and there was no trace of psoriasis over his body. His pulse was 78 ;

blood pressure, 143/83 ; R.B.C.'s had increased to five millions and W.B.C.'s had diminished to 5,500 per cc. of his blood. The urine was free of all abnormal constituents. The grafts were intact, not tender to touch, but perhaps smaller than before. The cremasteric reflexes were normal. The testes hung midway in the scrotal sacs and were distinctly larger, the size of an almond, firmer, and with testicular sensation.

7-4-30. He did not think it necessary to report himself during the long interval in spite of reminders, and was sorry for not writing about his condition; but he felt so well and so contented that he had forgotten his ailments and his doctors. Patient had put on 3½ stones in weight since his last examination. He was in the best of health. In the interval he had fought successfully and to the finish a very longstanding case of division of property between two branches of his family. He was now in possession of his own share of the ancestral property. He had made new revenue arrangements whereby he had almost doubled his income. He would not have believed if anybody had told him that such a change could ever be achieved as a result of a trivial operation. He wished me to do grafting operation on his wife, which I found unnecessary as she

was young, healthy and strong and in full enjoyment of all her mental and physical powers.

The grafts had been completely absorbed. *A very unexpected change, not noticed in any of my patients before, had taken place in him. The organ of generation had become larger and firmer. It was almost twice the original in circumference.*

6-3-31. Patient after long waiting, owing to my non-professional preoccupations, got himself examined. He had put on 18 lbs. since the last examination; he was looking the picture of health. His mental, physical and sexual life was satisfactory. The testes were quite large, firm, and tender and at the bottom of the scrotal sac. The cremasteric reflexes were normal.

Case 4. 3rd March, 1927. S. M. A., advocate, age 47. For the last three years he had noticed progressive shaking of head and trunk, tremors of the hands and instability of legs. He had also found it increasingly difficult to go on with his professional work. His memory had deteriorated. He had to make notes concerning details in conducting cases. Previously he had great debating powers, now he found himself at a loss to meet his opponent even in the most obvious points of law. As regards his sexual life, he had not been near his wife for the last

eight years, and for some twelve years before, he noted vita sexualis steadily declining. He had never been given to sexual excess at any time in his life, but now he found himself completely impotent.

Patient had come supported by two persons. Although only 47, he looked more like 65 or 70. His face was mask-like, devoid of all expression. The skin was like parchment. His head was continuously shaking and his hands and fingers moved in the typical pill-rolling movements. He could not raise himself up from the chair and flopped down when sitting. There were also coarse movements to and fro of his back, thighs and legs. His heart, lungs, and abdominal viscera were normal. His pulse was 58 ; blood pressure, 102/71 ; pulse low tension and collapsible. The examination of genital organs showed shrinkage of the organ of generation and atrophy of both testes, more marked on the left side. The left was soft, senseless, the size of a small almond. The right in the same condition but a shade bigger. Cremasteric reflexes were absent ; other reflexes were absent or sluggish. His urine was normal ; his blood showed marked anæmia and leucocytosis. Wassermann reaction was completely negative.

5-3-27. Two simian testes, each divided into four slices, were grafted, two over each of the recti muscles, and two over the two testes.

12-3-27. Patient had great mental and sexual excitement. He was irritable, restless, and had daily injections of hyoscine hydrobromide to control excitement and induce sleep. He also had slight fever between 99·4 and 100·8 for the first four days after the operation. The graft on the left testis showed slight congestion and inflammation 48 hours after the operation, but continued fomentations removed the inflammation. The grafts were all in good condition, except the one on the left testicle, which was still congested and painful on pressure. Patient detained after removal of stitches.

19-3-27. Patient free from fever during the whole week. The left testis was now neither congested nor painful. He was still suffering from some mental excitement and exaltation and also had sexual desire. He had been taking less and less support when getting out of bed, and he had also noticed some decrease in the shaking of his head, body, arms, and legs. Patient discharged.

19-4-27. He walked into my consulting room without any support. Except when excited, the nodding of the head, movement of

the body, hands, and feet were hardly noticeable. His face had much improved and had assumed normal expression. He said that mentally he felt a different person. He remembered things forgotten ; he could quote from books which he had read as a student at school. He was sleeping and eating much better. He was also feeling strong sex attraction which he had not felt for years. Examination showed the grafts intact and his two testes firmer and bigger.

15-12-28. I saw the patient when visiting his place of residence and found him changed. He looked like a young man of 35. He told me he had become father of a son since he saw me last. He had been working hard all these months to make up for arrears of work, and he was thankful for the new lease of active life which the grafting operation had given him.

21-12-29. The grafts were still palpable. His testes had assumed normal dimensions and normal reactions. He had put on 13 lbs. 10 oz. in weight and felt better than he had been for years.

6-2-31. He came to see me at Allahabad. I could hardly recognise him. The grafts had disappeared but his own testes had assumed normal sensibility. He was feeling very well indeed.

Case 5. 28th March, 1928. M. R. P., clerk in Secretariat, age 53. He had suffered from lassitude, want of general physical well-being, backache, loss of memory and loss of mental application. He had been repeatedly reprimanded by his chief for inefficiency and would have been obliged to retire if it were not for the fact that he had put in 26 years' service and had only to work for about a year to get his pension. He came for medical advice and inquired if he should apply for a year's furlough preparatory to retirement. Vita sexualis had been absent for the last 12 years.

31-3-28. Simian grafts were made under local anæsthesia, two quarter slices on either side over his testes.

7-4-28. Stitches removed. Patient felt as if he had a sudden access of mental and physical energy. He had also been thinking of sexual matters. Patient discharged.

23-6-28. He wrote to me that he was working much better than he had done for years. He now walked to and from his office, which was situated nearly three miles from his quarters, on an uphill road, whereas formerly he had been obliged to take a rickshaw. He had been having sexual congresses with his wife once or twice a week after years of abstinence.

11-11-29. He looked much improved in appearance and was cheerful. He had decided not to retire but to put in another five years, as he had two sons receiving university education.

12-12-30. He was now head of his department, having received promotion, and was also getting a better salary. He said he had received a new lease of health and happiness, but he complained that his wife had given birth to a child.

7-6-31. He wrote that he was quite well in mind and body and was doing his work efficiently.

ANALYSIS AND DISCUSSION OF CASES

Taking into account the sum total of improvements and their durability, simian grafts gave the second best results.

In all the five illustrative cases of homeotransplantation, the testicular grafts had either shrunken to small and negligible size or were completely absorbed in about four years, but not until after they had fully re-activated the patient's own testes and general endocrinal glandular system.

In this series, two instances of temporary initial mental and sexual excitement and exaltation were found, also anaphylactic symptoms

were noticeable in two of the cases. Besides general improvement in physical, mental and sexual conditions, notable cures were obtained in two cases of paralysis agitans—one early and the other advanced—in one case complete amelioration of extensive psoriasis without any other treatment, and in the other a notable increase in the size of the organ of generation.

Chart giving Analysis of 100 Cases treated by Simian Grafts.

Indications for Regeneration.	Numbers	Positive Results. Duration 1–2 Yrs.	2–3 Yrs.	3–4 Yrs.	Negative Results	Percentages. Successes.	Failures.
1. Senility ...	3	...	1	2	...	100%	...
2. Premature Senility ...	79	41	21	16	1	98·74%	1·26%
3. Testicular							
i. Anorchidia following excision of tubercular testes.	10	...	6	3	1	90%	10%
ii. Atrophy following accidents, mumps or gonorrhœa.	11	4	3	2	2	81 82%	18·18%
4. Nervous Diseases							
i. Paralysis Agitans	3	...	2	1	...	100%	...
ii. Psychoses and Psycho neuroses.	6	3	...	1	2	66 67%	33·33%
5. Heart and Circulatory Diseases							
i. Stenocardia.	1	...	...	1	...	100%	...
ii. Cardiac hypertrophy with arterio sclerosis and high blood pressure.	36	19	10	4	3	91·67%	8·33%
6. Impotence.	97	56	21	20	...	100%	...

CHAPTER VIII

HETERO-REGENERATION BY GRAFTING RAM'S TESTES

The grafting of testicular glands taken from mammals other than man or monkey has been advocated by many workers owing to the ease with which the material for graft can be obtained, its inexpensiveness, and also because of the claim that the results obtained by these grafts are as good as those from human or simian grafts.

As the result of my own extensive experience, I feel constrained to disagree with the above contention in certain details. It is true that the material for grafting is very easily obtained, but owing to the abundance of the material, and the ease with which it is obtained, sufficient care is not, as a rule, taken when getting it ; and due to the conditions prevailing in slaughter-houses, it is not possible to get the testes of rams, goats, or bulls in an aseptic condition unless extraction is done by the surgeon himself. The glands, moreover, are often bruised and damaged in the course of removal by the butchers, whereas in the case of human

and simian testes, the removal is performed with every caution and care by the surgeon himself, and grafting is done immediately from the donor to the host. Thus, besides the difficulty of these grafts taking, due to the greater dissimilarity between the tissues of the donor and the host than in the case of human and simian grafts, the damaged and infected grafts either do not take on, or if they do, they are liable to get infected. When, however, in spite of all the risks, the grafts do take on, they are absorbed more quickly than the human or simian grafts.

In my series of cases of hetero-grafting, I found it necessary to resort to repeated graftings, for the grafts got absorbed before the hormones produced had acquired sufficient quality and quantity or had continued over a sufficient period of time to produce the desired effects on the general endocrinal glands so as to re-activate the entire system. Hetero-regeneration, therefore, becomes not only expensive because of its repetition, but disappointing and irksome to the patient, and hence less practical than the human and simian varieties. My own conclusions, therefore, are that homo and homeo-regeneration are better, more effective, and in the long run, not very expensive.

The technique of the operation is the same as that described in previous sections so far as grafting is concerned ; the removal of the testes from the ram, goat, and bull is identical though different from human and simian donors. The removals should all be done preferably by the surgeon himself, or if that is not possible, by one of his skilled assistants rather than by the butcher. The testes should be removed immediately the animal has been slaughtered and before he is cold. After making the skin incision, the tissues of the cord are dissected, cleansed, and two silk ligatures are applied separately to the arteries, veins, and the vas, and these structures are separately cut between the ligatures, and last of all, the nerves are divided. The scrotum is then removed along with tunica vaginalis, washed with warm sterile normal saline, and then bottled in sterile, normal saline and kept at normal temperature. After using carbolic lotion 5, 15 or 20%, glycerinum acidi carbolici 5%, and 1/10,000 solution of double cyanide of mercury for some time, I have discarded them all in favour of sterile normal saline. The graft must be made within an hour, if possible, of the removal of the testes from the animals, but the best results are obtained by immediate operations on the donor and

the host simultaneously.

THREE ILLUSTRATIVE CASES

Case 1. 3rd April, 1928. M. A. N., business man, age 64. He had been feeling very weak and run down for the last seven years, following a severe attack of influenza complicated with broncho-pneumonia. After about seven months' illness, when he became well, he noticed general deterioration in his mental, physical and sexual powers which persisted in spite of the best available treatment. Patient, although tall and well-built, with a massive frame, was very emaciated, with sallow, wrinkled face and a very pronounced stoop. His pulse was intermittent, 96, with sclerotic arteries ; blood pressure, 175/101 ; there was a marked dilatation of the right side of the heart. The liver was slightly enlarged, the spleen was palpable. The left lung was full of moist sounds; he had wheezing breath. There was nothing to note regarding the abdominal organs. His genital organs showed marked deterioration ; both the testes were soft and smaller than normal size—small almonds. The cremasteric reflexes were very sluggish. His prostate gland was somewhat enlarged ; he suffered from frequency of urination. Beyond high acidity and vesical catarrh,

there was nothing abnormal in the urine.

5-4-28. For years he had reared a very good stock of sheep, and a powerfully built young ram was selected and four slices of one of his testes were grafted on to the patient's rectus abdominis muscles, under local anæsthesia.

12-4-28 He had great nervous excitement for two days, forty-eight hours following the operation. There was also rise of temperature for two days, the temperature ranging between 102/3. The grafts were perfectly healthy and even at the time of temperature, showed no congestion or inflammation. It was, therefore, concluded that the symptoms were due to anaphylaxis. Patient discharged.

12-5-28. Patient had improved appetite and felt much better in mind and body. He also had libido. His pulse was regular, 74 ; blood pressure, 148/100. The grafts were intact and did not seem to have undergone appreciable change. His testes were bigger and firmer. The cremasteric reflexes were almost normal.

12-11-28. His appearance had undergone remarkable change. His skin was pink, glossy, and soft. The hair of his head, moustache and beard was thick and glossy. There was a wonderful light in his eyes and a very pleasant

HETERO REGENERATION—RAM'S TESTICULAR GRAFT



Case I

Three years after grafting

smile on his face. His voice was deeper and of a different timbre from what it was before. He talked with an air of confidence and had bought out his partner. He had started building new tenements involving large expenditure. Vita sexualis was quite satisfactory. He could hardly believe that a man at his age could live such a sexual life.

12-12-30. He had been out, establishing a new branch of business in two new provincial centres. He was now managing about a dozen branches in each of the two provinces. His mental capacity had surprised all his old associates and friends. He wished to build and endow a hospital for reactivation of old people, provided I undertook the supervision.

12-6-31. He was looking the picture of health. He had no cold nor cough during the winters since the operation. His pulse was 72 and regular ; his blood pressure, 130/90 ; the grafts were still palpable, though nearly a quarter of the original size ; his testes were large and firm.

Case 2. 15th February, 1927. T. K. S., age 74. Tall, 6ft. 5½ inches ; massively built, straight-limbed, typical Rajput. He had been a meat-eater and a heavy drinker all his life. He had a very much hypertrophied and enlarg-

ed heart, which for the last few years had been giving him a great deal of trouble and inconvenience. He did not mind palpitation and shortness of breath on exertion, but he did mind his inability to go out riding and shooting. He had been feeling as if he had no power left in his backbone. Often he had to drag himself to do things. His face was deeply furrowed, his skin was dark brown with a sallow tinge. Even the skin over his body was loose and inelastic. The arteries were thickened; pulse was 118, irregular ; blood pressure, 210/108 ; there were loud bruits at the apex and the aortic area. The liver was 6 inches below the costal margin and hard. He had dropsy of both feet. There was free fluid in the abdomen and the pleural cavities. He was put on treatment for cardiac disease after withdrawing fluid from his pleura and peritoneum. After six weeks' treatment, there was a marked improvement in his heart condition. He then insisted on grafting. He was free from syphilis or gonorrhœa. Wassermann reaction was completely negative.

27-3-27. Examination of the genital organs revealed almost complete atrophy of the testes. They were soft, devoid of sensation and a little bigger than two peas. He had four slices of a young ram's testes grafted on to

the two rectus abdominis muscles.

7-4-27. The grafts were intact and normal. He had noticed nothing in the interval except that his breathing was a little better.

8-10-27. He felt a great deal better in his general health. He had been eating better and his bowels had acted regularly. He could now walk slowly for a mile to a mile and a half without loss of breath and without fatigue. His pulse was regular, 84, and blood pressure, 180/100. His face looked smoother. He had not noticed any change in sexual life.

7-9-28. He was at Simla, where his heart was strained. He got a cardiac seizure and came down to Delhi in a critical condition. After three weeks' treatment he slowly improved. He was warned against any such indiscretion and sent back home.

11-11-28. Patient was better than last time. His heart was regular and he could walk about in the house without loss of breath. He insisted on having a second graft, the first graft having completely disappeared ; his testes were the size of an almond, and a little firmer. His blood pressure was 166/99.

17-12-28. He had a young ram's testes grafted in four slices, two on either side of his testes, under local anæsthesia.

25-12-28. Stitches removed. Grafts sound. Patient felt stronger and was discharged.

15-3-29. Patient's general condition was much improved. He had markedly increased in weight. His grip was powerful. His pulse was 72 ; blood pressure, 148/99 ; heart was fully compensated ; there were no adventitious sounds heard in any area. He had sexual desire but had practised abstinence, as he had been warned.

12-2-30. Patient felt extremely well. He could walk slowly for several miles. He tried riding against my advice but felt precordial discomfort with some shortness of breath and, therefore, gave it up. He had put on weight.

19-6-31. Patient came intent on having another graft, but examination revealed the testes to be almost normal in size and the second graft had been completely absorbed. I told him it would do him no good to have any more grafts and if he were careful and lived very quietly, he would probably live a long life.

Case 3. 11th March, 1927. R. S. R., age 47. He had led a very wild life as a young man. Had contracted gonorrhœa and syphilis. He was a heavy drinker. He found that he had lost vita sexualis completely for the last eleven years. He had been undergoing all forms of

treatment as he was anxious to have an heir to succeed him. He was a thoroughly broken-down, evil-looking man, with a thin, wasted body, hollow sunken cheeks, dark sallow complexion, with bad pyorrhœa, foul breath, thickly coated tongue, pulse small, running 120; blood pressure 105/63, heart weak, but without any organic disease ; liver enlarged ; intestines loaded; nervous system strung; reflexes all exaggerated ; tremors of the hands ; examination of blood showed marked anæmia and some leucocytosis ; urine was full of pus and casts, a trace of albumen ; Wassermann reaction was strongly positive ; the genital organs showed scars of healed chancres, glands in the groin, thickening of both the cords ; the testes showed thickening, also both the epididymi slightly thickened. Patient was put on anti-syphilitic and anti-gonorrhœal treatment for nine months, and asked to return with the reports of his blood and urine.

11-12-27. Patient had improved. His urine was free from pus, threads, albumen and casts. There were only a few epitheleal cells of the bladder and urethra. Wasserman reaction had been repeatedly negative for the last three months. The thickening of the cord, epididymi and testes was also less obvious fol-

lowing treatment by injections.

18-12-27. Four grafts of quarter slices of a young ram's testis made on to the rectus abdominis muscles.

27-12-27. Patient was reported to have been very boisterous two days after the operation. He quarrelled with the house-surgeon who stopped him from seeing some women. He was reported to have been mad with sexual excitement. He felt he did not care what happened afterwards provided he could indulge his sexual desire at the time. He was sorry for having behaved so rudely to the house-surgeon and for forgetting my instructions. The grafts were in good condition. Patient was discharged after removing the stitches and was warned against any sexual congress until he was permitted to do so.

19-4-28. Patient had been writing and sending telegrams almost every week asking permission for sexual indulgence, but as his wife, who had contracted syphilis and gonorrhœa through him, was still under treatment and was not certified as cured, he was told to wait. He looked better, had put on 30 lbs. in weight. His face had lost its former vicious look, he now appeared pleasant ; his pulse was 66, regular and of good volume ; his blood pressure was

128/89. He had all his teeth extracted and wore a denture ; his tongue was clear and his breath was healthy ; the grafts had shrunken to one-fourth their original size ; his testes had become more or less uniform but some nodules were still felt.

OVARIAN GRAFTING

21-6-28. His wife came for examination, with a report from her doctor of being free from syphilis and gonorrhœa. She had complete aversion from any sexual congress although she was young, healthy and robust.

27-6-28. Sheep's ovaries divided in four slices were grafted on both sides of her rectus abdominis muscles under local anæsthesia.

5-7-28. Stitches removed. Both the grafts were in healthy condition. Patient reported feeling bright and happy. Was discharged.

7-9-28. Both the husband and wife looked in the pink of health. They had resumed their normal sexual relations. The wife thought she was pregnant, having missed a period.

7-10-28. The husband came, reported that he was fit and that his wife had missed her second period. Examination of the man, however, revealed that the grafts had been totally absorbed.

11-12-28. He reported that his wife was keeping good health and was visibly pregnant ; he felt vita sexualis declining.

22-12-28. Four grafts of ram's testes were implanted on to the rectus abdominis muscles.

30-12-28. Stitches removed. Patient discharged. He reported that he had great sexual exaltation forty-eight hours after the operation, but he controlled himself, having had a lesson before.

9-9-29. He and his wife visited me with a large number of people and paraphernalia in honour of the infant heir. His second graft had also shrunk to half its original size, but his testes had assumed almost their normal consistency and sensibility. He felt quite well mentally, physically and sexually. His wife had no more aversion from sexual congresses.

9-9-30. The implants had again been absorbed, but the testes were large and firm. He, however, thought that there was noticeable lessening of his vita sexualis, but he was not worrying because he knew where to go for regeneration.

11-5-31. He was looking quite plump, well-nourished and strong. He had had a second son, and he was living a good and regular life. He found that he was able to excel the

oldest and most experienced official in supervising and controlling the administration of his estate.

ANALYSIS AND DISCUSSION OF CASES

The first and second illustrative cases are those of senility. In the first case, besides mental, physical and sexual deterioration, there was enlarged prostate, cystitis and bronchitis. In the first case, like the third, within the first week after the graft, there was marked nervous and sexual exaltation, but it was temporary. There were also anaphylactic symptoms, the temperature rising to 102 and 103. In both the first and second cases there were cardio-vascular changes. In the first case, only one graft was necessary ; in the second, two grafts ; but in both the cases, improvement in mental, physical and sexual capacities was remarkable. In the first case, the bronchitis was completely got rid of as well as cystitis.

The third case was one of premature senility, the patient having led a very fast life. He had contracted both syphilis and gonorrhœa. Two grafts were found necessary completely to regenerate the system, but the results were remarkable, the improvement having changed the patient almost out of recognition.

Chart giving Analysis of 60 Cases by Grafting Ram's Testes.

Indications for Regeneration.	Numbers.	Positive Results. Duration.			Negative Results.	Percentages.	
		1-2 Yrs.	2-3 Yrs.	3-4 Yrs.		Successes.	Failures.
1. Senility	3	...	1	1	1	66·67%	33·33%
2. Premature Senility	27	5	7	12	3	88·89%	11·11%
3. Nervous Diseases. Psychoses and psycho-neuroses	5	1	2	1	1	80%	20%
4. Heart and Circulatory Diseases.							
i. Stenocardia	1	...	1	...	...	100%	...
ii Cardiac hypertrophy with arterio-sclerosis and high blood pressure	31	...	15	15	1	96·78%	3·22%
5. Impotence	33	19	8	5	1	96·97%	3·03%
6. Repeated Graftings	38	3	17	16	2	94·74%	5·26%

CHAPTER IX

HETERO-REGENERATION BY GRAFTING GOAT'S TESTES

The general remarks made in the previous section apply, *mutatis mutandis*, to the grafting of goat's testes. It has only to be added here that rams are more powerful animals both physically and sexually, although less intelligent than the goat. So far as the life of the graft is concerned, there is not much difference between the two varieties, the goat's graft lasting to about the same period as the ram's, the facility in securing the grafts and the risks involved being about the same. If anything, goats being slaughtered in much larger numbers in India than rams, their testes are more easily secured.

The technique of the operation, both as regards removal from the donor and implanting in the host, is identical with that described in the preceding section.

TWO ILLUSTRATIVE CASES

Case 1. 9th January, 1927. N. K., poultry seller, age 53. Had been a wrestler and took to poultry business after foul play by his

opponent eight years ago, the latter having overpowered him by catching hold of and twisting his testes during a wrestling bout, when he was overcome by excruciating pain and fainted away. The testes were bruised, swollen and tender for nearly a fortnight, after which they became small and soft, and he found, as a result, that he lost all sexual power. Since this accident he had found a great change in his life. He had become weak-minded and vacillating, he had lost all energy and initiative, and he found himself inclined to run away from all danger. He had made himself almost destitute by using expensive medicines, but found no improvement in his condition.

Examination showed him to be a very well-built, well-proportioned athlete. There was no organic disease in any part of his body. Examination of his genital organs showed the testes to be scarcely palpable. He was asked to get a human donor, but found it impossible. Neither was it possible to secure a simian donor at the time.

16-1-27. A strong goat was therefore used for testicular grafting. Two quarter-slices of goat's testes were grafted on either side over the rectus abdominis muscles.

23-1-27. He had headache, nausea, vomit-

ing and extreme nervousness for three days commencing thirty-six hours after the graft. Anaphylaxis was the only explanation for these symptoms. The grafts were normal. Patient discharged.

2-2-27. Patient came of his own accord and reported having had wet dreams on two successive nights. He was also getting morning erections. The grafts were healthy and intact. His testes could now be felt as two little nodules the size of small peas.

11-6-27. He thought a great deal over sexual matters and sometimes he had intense desire, but he was not able to do the sexual act. The grafts seemed softer and smaller.

11-11-27. He was still in the same condition and begged me to do something in order to improve it and enable him to live a normal sexual life. The grafts were all but absorbed. His testes were of the size of cherries and firmer.

11-1-28. A second graft of goat's testes was made over the recti muscles.

18-1-28. Patient had great sexual exaltation for four days commencing from two days after the operation. The grafts were healthy and intact ; stitches were removed and the patient discharged.

18-3-28. Patient felt well in himself. He felt confident, courageous and manly. He had sexual congresses with his wife twice a week, and was quite satisfied with the result of the operation. The grafts were intact and normal in consistency. His testes were the size of almonds, quite firm, and had normal testicular sensation.

3-12-28. He was happy and contented. He had restarted wrestling. He could contest with young men of 25 and beat them. He was thinking of challenging the adversary who had played him foul. He would teach him a lesson if he could only get him to accept his challenge, of which he was very doubtful. His wife was pregnant.

9-11-30. He was father of a son. He had started a big poultry farm of his own in a village near by. The grafts had all but disappeared, but his testes were normal in size, consistency and sensibility.

10-9-31. He came with his little boy. He was happy and was in full enjoyment of his newly acquired powers. The grafts had completely disappeared, but his own testes were functioning normally.

Case 2. 2nd February, 1928. L. B. D., general merchant, age 49. Seven years back,

he had a fall when supervising the construction of a house and injured his back and both the testes. He had incontinence of urine and faeces for six months after the accident and complete loss of virility ever since. He had developed claustrophobia and also partial agoraphobia. He had become very suspicious and had accused his wife of infidelity without cause. He sometimes sat and cried for no rhyme or reason, which relieved him.

Examination showed pulse, 72, regular; no obvious arterial thickening ; heart and lungs, normal ; abdominal organs, normal ; urine, normal ; blood normal ; no syphilis or gonorrhœa ; blood pressure, 140/88 ; weight 11 stones 3 lbs.; height, 5 ft. 5½ inches; patient's expression worried, his look was distant ; he was absent-minded ; questions had to be repeated before he answered them and when answering he repeated his words and sometimes changed them while doing so. Memory, bad ; concentration, almost nil ; reflexes were either sluggish or absent. The organ of generation was undersized and bent ; the testes were small and devoid of sensation ; they were also softer than normal.

10-2-28. Goat's testicles grafted, two quarter slices over each rectus muscle.

19-2-28. Three of the grafts were normal

and intact. The right lower one extruded from the wound. The wound was refreshened and resewn. Stitches removed from the other three. Nothing subjective or objective reported. Patient kept in.

26-2-28. The freshly sewn wound had healed up. The stitches were removed but the right lower graft was tender and slightly congested. Patient discharged after warning to be careful.

4-3-28. Patient reported no improvement. He, however, felt more cheerful. The grafts were intact.

9-6-28 Patient came smiling and shook hands vigorously. He said he had been a fool to upset every one in the house when he could have come to me earlier and got cured. He was grateful for a renewed life. He was quite normal in mind and body. He was working at his business as he had done during the most successful years of his activity. The grafts had diminished in size and were softer than before. His own testes were larger, firmer, and with better sensibility. The cremasteric reflexes had returned. All other reflexes were also present, although sluggish.

12-12-28. He reported that he was better mentally but his sexual powers had been de-

HETERO REGENERATION — GOAT'S TESTICULAR GRAFT





CASE II

On the day of grafting

Two years ten months after

clining. The grafts had been completely absorbed. His testes were almost the same as at the last examination. A second graft was advised.

12-3-29. Goat's testes were grafted a second time, on the two recti muscles.

19-3-29. Patient had great mental and sexual exaltation ; grafts were intact ; stitches removed and patient discharged.

9-11-29. Patient felt well. He was satisfied with his mental and sexual powers. The grafts were intact but had diminished to half their size. His testes were now quite normal in size, consistency and sensibility. The cremasteric reflexes were brisk.

1-12-30. Patient was well in body and mind. His sexual life was normal. The grafts had been absorbed. His own testes were normal.

11-12-31. He reported himself and was found as fit as before. He had become father of a little girl.

ANALYSIS AND DISCUSSION OF CASES

The above two illustrative cases are rather unusual in their own way. They are both cases of atrophy following injury to the testes, the first, due to foul play during a wrestling bout ; the second due to an accidental fall causing

injury to the lumbar centre with parosis of the lower extremities, temporary incontinence of urine and stool. In both there were, besides complete loss of vita sexualis, psychic and psycho-neurotic changes. In the first case, a professional wrestler became mentally weak, vacillating and timid. In the second, a shrewd business man became nervous, emotional, deficient in mental capacity, unduly suspicious of his wife, afraid of going in open places or of remaining in a closed room. In both cases two graftings were found necessary. The first patient had anaphylactic symptoms after the first grafting, and great sexual exaltation after the second grafting. In both cases complete re-activation of the endocrinal glandular system was effected only after the second grafting. Besides complete return of sexual powers, the mental, psychic, and psycho-neurotic symptoms completely disappeared and the patients regained their mental capacity, their physical powers, their courage and even the pugnacity of the typical male animal.

The first case is remarkable in one particular. At the time of the first examination, the patient's testes had atrophied to such an extent as to be almost impalpable. A month and half after the first graft, they were felt as two small nodules, the size of peas. Ten months later,

they were larger still, the size of small cherries. Two years and 8 months after the second graft, the testes were quite normal in size, consistency, sensation and function. This raises the question whether new glands are formed out of atrophied remnants. In this particular respect, this case is certainly most remarkable.

Chart giving Analysis of 40 Cases treated by Hetero-Regeneration by Grafting Goat's Testes.

Indications for Regeneration.	Numbers.	Positive Results. Duration			Negative Results.	Percentages.	
		1–2 Yrs.	2–3 Yrs.	3–4 Yrs.		Successes.	Failures.
1. Premature Senility . .	40	21	13	4	2	95%	5%
2. Testicular Atrophy (following mumps, accident or gonorrhœa.)	19	6	5	4	4	78·95%	21·05%
3. Nervous Diseases. Psychoses and psycho-neuroses.	5	1	3	1	...	100%	...
4. Heart and Circulatory Diseases. Cardiac hypertrophy with arterio-sclerosis and high blood pressure.	11	6	3	1	1	90·91%	9·09%
5. Impotence. ...	38	11	10	15	2	94·74%	5·26%
6. Repeated Graftings ...	39	19	11	8	1	97·14%	2·56%

CHAPTER X

HETERO-REGENERATION BY GRAFTING BULL'S TESTES

During the course of the Second International Congress on Sexology held at Vienna, it was suggested by some of the workers in this field of research that testicular grafts of animals well-known for their fecundity and sexual powers would produce hormones which, both as regards quality and quantity, would re-activate the endocrinal system more quickly and with greater certainty. Many such animals were mentioned, *e.g.*, the bear, the bull and the stallion. I therefore, took the opportunity of grafting bull's testes, but I did not succeed in securing materials from the horse and the bear. In securing bull's testes similar religious scruples were encountered as in the case of monkeys, the cow and the bull being considered, if anything, more sacred than the former.

In the forty cases treated by grafting bull's testes the difficulties in securing the material were considerable and much of the material

obtained proved useless. There was thus a limited field of application to this variety of grafting. On the whole, I have not found any marked superiority of bull's grafts over sheep or goat's and consider the latter easier and better among the lower mammals.

The technique of the extraction and grafting are identical with those described in the previous chapters.

TWO ILLUSTRATIVE CASES

Case 1. 3rd February, 1927. C. M., age 51. Led a very wild life as a young man. From the age of 17 to the age of 34 there was hardly a day when he did not indulge in orgies. He contracted syphilis and gonorrhœa at the early age of 21, and continued in his reckless career without proper treatment until, at the age of 34, he was a wreck. When he found himself destitute and penniless he regained his senses and became a paid property agent to a near relative of his. He got himself treated for both syphilis and gonorrhœa, but had never regained his health.

His present condition showed him to be a little, prematurely aged, shrivelled up old man. He was bald, with deep furrows and scars of acne on his face, which was pallid. His skin

under the chin and around the neck hung loose. His chest and abdomen were sallow, devoid of all hair and pigmented. He was emaciated and had a marked stoop. His pulse was 91, regular and hard; blood pressure was 196/110; his heart was hypertrophied and dilated ; his lungs were full of moist rals and rhonci ; he had wheezing breath ; the liver was enlarged and hard ; the intestines were loaded ; his teeth were all extracted, he wore a denture. The urine showed a fair quantity of pus and epitheleal cells from the bladder and urethra. His prostate was not enlarged but felt hard and tender. Wassermann reaction was positive. His organ of generation had three scars ; his testes were small, the size of almonds, soft and with slight sensation. The cremasteric reflexes were sluggish. Examination of his blood showed marked anæmia and a slight leucocytosis. His nervous reflexes were all very sluggish; weight 104 lbs.

He was started on anti-syphilitic treatment as well as treatment for his nephritis and cystitis.

13-8-27. Patient looked better ; his Wassermann reaction had been repeatedly negative for the last three months. His urine contained traces of albumen but was free of pus, casts and epitheleal cells.

15-8-27. Four quarter slices of a young bull's testis were grafted on to his rectus abdominis muscles under local anæsthesia.

22-8-27. The grafts were intact. Stitches were removed. He reported that he felt much better and stronger 24 hours after the operation. He was discharged.

11-11-27. He felt stronger. His weight was 128 lbs. His appetite and his digestion had greatly improved. He had changed in looks ; the facial and body skin was glossy, soft and moist. He had increased his capacity for work and, what seemed to him a great surprise, he had regained vita sexualis. The grafts were quite healthy but felt smaller. His own testes were firmer and slightly larger. The cremasteric reflexes were brisk.

1-6-28. He had regained 15 lbs. in weight and looked plump. He said he had energy and vitality which he had not possessed for the last twenty years. His sexual life was normal. He had been warned against sexual excess and against drinking. The grafts had diminished in size. His testes were slightly bigger and had complete sensibility.

6-12-29. He was feeling well, but vita sexualis was on the decline. His weight was 11 lbs. less than last time. The grafts had

completely disappeared. His testes had also grown softer and, possibly, smaller.

12-12-29. A second graft of bull's testis in four quarter slices was made, this time over the two testes.

19-12-29. Patient had marked sexual exaltation almost the whole of the week. The grafts were intact. Stitches removed. Patient discharged.

12-6-30. Patient looked well. He had grown stouter, had put on two stones in weight ; pulse, 68 ; blood pressure, 141/89. The grafts were quite firm and intact. The testes had doubled their size. Vita sexualis almost perfect.

1-5-31. He looked strong and healthy. Had been working hard and had been able to get back part of his property. He was now partner with his cousin whose property agent he had been before. He had married. The grafts were completely absorbed, but both his testes were large, firm, with testicular sensation and brisk cremasteric reflexes.

Case 2. 3rd April, 1927. S. A. A., teacher in a religious seminary, age 59. Five years ago he had what was called a stroke of paralysis of both the lower limbs with incontinence of fæces and urine. He was bedridden for three weeks. The paralysis passed off after

this period, and he was gradually able to walk about. His rectal incontinence and loss of control over the urine also gradually improved, but his vita sexualis had never returned.

Patient was tall, 6ft. 3½ inches, thickly built, with ascetic appearance and thick flowing beard beginning to get grey. He had also a thick head of hair. He had a deep voice and broad chest. His skin was parchment like, tough and inelastic. With the exception of the grinders and the canines, he had lost all his teeth. His pulse was 78 ; blood pressure, 180/100 ; his heart was slightly hypertrophied, otherwise normal ; his lungs and abdominal organs were normal. His organs of generation were small compared to his size ; the testes were palpable with difficulty. He had enlarged prostate and cystitis ; his lower extremities were thin, with considerable muscular wasting ; the patellar reflex and ankle clonus were sluggish. He could only walk slowly. His weight was 134 lbs.

10-4-27. Bull's testicular grafts made at the two recti muscles under local anæsthesia.

17-4-27. No subjective or objective symptoms. Grafts healthy and intact. Stitches removed and patient discharged.

17-5-27. He did not get up for urination

22

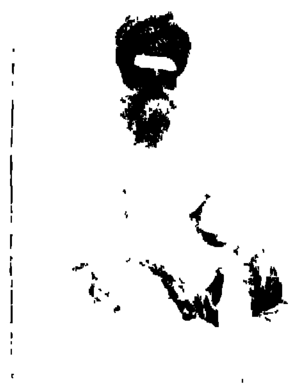
at night, and during the day he could hold his urine for 5 or 6 hours. He felt stronger. He had restarted giving lessons at the religious seminary. He found his memory improved, but vita sexualis had not completely returned, although he had morning rise and had wet dreams twice. The grafts were healthy. His testes were the size of two almonds and had testicular sense, but were still soft. His blood pressure was 148/96 ; pulse 78.

7-7-28. He had gained 21 lbs. in weight. His skin was soft, glossy and elastic. His hair was thicker ; pulse, 66 ; blood pressure 144/90. He felt well. He was now principal of the religious seminary and, besides giving lessons, had to do several hours administrative work, but did not feel tired. He had better digestion than he could remember having had ever before. His sexual powers had returned, but he was cautious and had sexual congress once or twice a month. The grafts were completely absorbed. His testes were about half the normal size, fairly firm, with full sensibility. The cremasteric reflexes were normal.

7-12-28. He came complaining of loss of sexual powers, although in fairly full possession of his mental and bodily health.

14-12-28. A second series of four quarter

HETERO-REGENERATION—
BULL'S TESTICULAR GRAFT



Case II

Two years, two months, eleven days after grafture

grafts of a young and specially powerful bull's testis were grafted over the two testes. This was a prize bull, run over by a motor lorry, and the testes were immediately secured after the bull had been slaughtered.

21-12-28. He had great sexual exaltation lasting the whole period. The grafts were healthy and intact. Stitches removed. Patient discharged.

21-6-29. He came delighted and with two new patients, both of them old colleagues. He was looking well and enjoying mental and physical health. His sexual powers were at their height, but he had not exceeded the limits laid on him. The grafts were smaller but intact. The testes had assumed bigger size than normal ; firm and sensitive.

31-12-30. He was in the enjoyment of his mental, physical and sexual powers. He had never felt better in his life. He was working twelve to fourteen hours a day without fatigue. He went for an hour's walk in the morning and in the evening ; his appetite was good. The grafts had disappeared. His testes were large, firm and sensitive.

ANALYSIS AND DISCUSSION OF CASES

Of the two illustrative cases, the first was a

case of premature senility in a man who had indulged in great excess both as regards sexual matters and as regards drink, so that at the age of 34 he had become a total wreck. He had also contracted gonorrhœa and syphilis. He was bald, with a wrinkled, furrowed and scarred face, and markedly anæmic. His skin was sallow, pigmented and hanging loose ; his body emaciated, stooping ; there were cardio-vascular degenerative changes, chronic bronchitis, intestinal stasis with toxæmia, arthritis, cystitis, with fibrous prostate, nephritis, soft, small and atrophied testes, sluggish reflexes, weight 104 lbs. at time of examination. Three months after grafting there was marked improvement in appearance and mental, physical and sexual powers ; 24 lbs. increase in weight. Five and a half months after, 15 lbs further increase in weight together with great access of energy and vitality ; testes were bigger and more sensitive. A year and four months after, the first grafts completely disappeared ; testes softer, and possibly smaller. Second grafts made ; six months after second graft, the patient gained 2 stones in weight, cardio-vascular symptoms disappeared, testes were double their original size ; sexual power perfect. A year and 5 months after second graft, greatly increased capacity for

work, second grafts completely absorbed, but his own testes large and firm, with complete sensation and full function.

The second case was also one of premature senility but with complication of recent incomplete paraplegia of the lower extremities with partial fæcal and urinary incontinence, which the patient had got over, but with complete loss of vita sexualis : skin tough, inelastic, parchment-like; cardiac hypertrophy, high blood pressure, fast pulse ; testes palpable with difficulty ; enlarged prostate, marked cystitis, wasted lower extremities, slow unsteady walk and sluggish reflexes. Five weeks after first grafting, cystitis better ; he felt generally stronger. There was return of mental powers ; testes were larger ; improvement in sexual power. Three and half months later, skin was found soft, glossy, elastic, with thicker hair, pulse and blood pressure normal. He had gained 21 lbs. in weight, and improved mental powers, better digestion, improved sexual powers, but the grafts had been completely absorbed. His own testes were quite normal. One year and 8 months after the first graft, there was some loss of sexual power, but mental and physical powers were good. A second graft was made. There was a transient sexual

exaltation immediately following the graft. Six months after the second graft, he was in full enjoyment of mental, physical and sexual powers. His testes were bigger than normal, sensitive, with cremasteric reflexes brisk. Two years after, the second graft had disappeared, but his own testes were functioning fully and were large and firm. His capacity for work had increased immensely.

Chart giving Analysis of 10 Cases of Hetero-Regeneration by Bull's Grafts.

Indications for Regeneration.	Numbers.	Positive Results. Duration			Negative Results.	Percentages.	
		1–2 Yrs.	2–3 Yrs.	3–4 Yrs.		Successes.	Failures.
1. Premature Senility ...	40	23	9	7	1	97·5%	2·5%
2. Prostatic Inflammation and cystitis	19	9	5	3	2	89·48%	10·52%
3. Heart and Circulatory Diseases. Cardiac hypertrophy with arterio-sclerosis and high blood pressure.	27	15	5	3	4	85·19%	14·81%
4. Impotence ...	40	4	2	33	1	97·5%	2·5%
5. Repeated Graftings ...	40	8	29	2	1	97·5%	2·5%

CHAPTER XI

SUMMARY OF RESULTS

Although the actual number of cases treated by me was between six and seven hundred, it has been possible to keep in touch with only four hundred and forty cases. Out of this total there were one hundred cases of auto-regeneration by means of vaso-ligature and vasectomy (Steinach's operation); one hundred cases of homo-regeneration by means of human testicular grafting; one hundred cases of homeo-regeneration by simian testicular grafting; sixty cases of hetero-regeneration by ram's testicular grafting; forty cases of hetero-regeneration by goat's testicular grafting and forty cases of hetero-regeneration by bull's testicular grafting. In all varieties except human testicular grafting, the number of cases given were taken from actually a larger number of cases treated. They were selected according to their serial number without any other regard except that contact was maintained up to four years. In the case of human testicular grafting, only one hundred cases were treated by this method. No other worker in this field of research has, to my

knowledge, been able to report his observations based on as many cases of human testicular grafting as given here.

It would be tedious to go through the notes of the four hundred and forty cases in detail. I have, therefore, given only five per cent. of each variety and have selected cases which bring out specific points in an outstanding manner. It is not claimed that all cases, or even a majority of them, received such benefits as the illustrative cases show ; on the contrary, it must be made quite clear that the impression created by much loose and irresponsible writing in the lay press and also, unfortunately, exaggerated reports in a section of the medical press, have created a wholly erroneous impression concerning the infallibility of the methods practised for regeneration. The truth, as the following analysis of the 440 cases in relation to the indications for regeneration show clearly, is far from this. A glance at the chart will prove that the applicability of the various methods of regeneration is strictly limited to certain well-defined and known conditions of human derangements, and that the net results, though certainly remarkable, do not always indicate a complete success. There is a certain percentage of failures relating to every indication for treatment. It must,

therefore, be clearly understood that the methods practised for regeneration, though certainly a new and powerful weapon in the scientific armamentarium for the alleviation of human suffering and for arresting the processes of degeneration, decay, and senility, are by no means a panacea for all human ailments.

Chart giving Analysis of 440 Cases in Patients under Observation up to Four Years for various Indications for Regeneration.

Indications for Regeneration	Numbers	Positive Results. Duration. 1-2 Yrs.	2-3 Yrs.	3-4 Yrs.	Negative Results.	Percentages. Successes.	Failures.
1. Senility.	128	12	25	21	40	68·75%	31·25%
2. Premature Senility	178	39	57	60	22	87·65%	12·35%
3. Prostatic							
i. Hypertrophy ..	16	...	...	13	3	81·25%	18·75%
ii. Inflammation	55	...	.	44	11	80%	20%
4. Testicular							
i. Anorchidia (following surgical excision of tubercular testes).	11	3	2	1	5	54·55%	45·45%
ii. Atrophy (following accidents, mumps, or gonorrhœa)	131	61	21	17	32	75·58%	24·42%

Indications for Regeneration.	Numbers.	Positive Results Duration. 1–2 Yrs.	2–3 Yrs.	3–4 Yrs.	Negative Results.	Percentages. Successes.	Failures.
5. Nervous Diseases. i. Paralysis Agitans ...	12	4	3	2	3	75%	25%
ii. Psychoses and psycho-neuroses.	19	...	2	8	9	52·64%	47.36%
6. Heart and Circulatory Diseases. i. Stenocardia	6	...	...	5	1	83·34%	16·66%
ii. Cardiac hypertrophy with arterio-sclerosis and high blood pressure.	287	151	65	56	15	94·78%	5·22%
7. Impotence ...	76	..	...	68	8	89·48%	10·52%
8. Repeated Graftings	140	101	21	15	3	67·86%	12·14%

EXAMINATION OF CLINICAL RESULTS

So far the clinical results have been merely described. They must now be examined with a view to ascertain the effects obtained by the various methods of regeneration and the number, extent, and persistence of the results obtained by them. It is unlikely that these extensive and lasting effects are produced merely by auto-suggestion or solely as a direct result of the insignificant operation of vaso-ligation, vasecto-

my or testicular grafting. Endocrinology alone can explain these phenomena. We know the important role played by the internal secretion of the glands during the course of normal physiological life. We also know how disorders and disfunctions of these glands produce far-reaching effects in the organism. It has been established beyond doubt that an important role is played by the sexual glands in these processes, and that physiological and premature senility are dependent on the defective functioning of the glands. We now know, without any doubt, that *within certain limits* we can, through these glands, arrest and even reverse the processes involved in the approach of old age.

By implantation of the testicle, or in the alternative, by ligation and excision of a portion of the spermatic duct, tissue changes through back pressure on the parenchyma of the testicle and proliferation of the interstitial tissue are produced. This causes increased production and output of the testicular hormone into the circulation. The increased output augments the hormono-poitic activity of the endocrine system, which in its turn acts on the whole protoplasmic activities of the organism, thus producing reactivation of the entire body.

Having found numerous atrophic semini-

ferous tubules along with hypertrophic interstitial tissue in the testes at each period of life, Kyrle[1] concluded that atrophy and hypertrophy of both the tissues were based on an automatic physiological process. Ageing is caused, according to him, by cessation of this automatic process of alternating degeneration and proliferation of the seminiferous and the interstitial part of the testicle. By implantation of testicles or vaso-ligature and vasectomy, a fresh impulse is given to the arrested automatic process which evokes refunctioning of the natural physiological process.

As the result of the various operations for regeneration, the following constant clinical results appear, which may now be discussed *seriatim* :--

1. *Increased Appetite.* This symptom appears early in the majority of cases, in some after a few weeks only ; but it is almost always found. It varies from a slight increase to that of ceaseless appetite, at times ravenous hunger.
2. *Increase in Weight.* With the increased oxidisation and quickened combustion, the deposition of fat is generally dimi-

1. Kyrle. *Ist Steinach's Lehre Zwingend? Med. Klinik. 1921. Nr. 34-35.*

nished, but in spite of change in contour and apparent slimness, the weight increases. This is due to the improved development and tone of the muscular system, and increase in quantity of blood and plasma. The weight has been noted to increase constantly over a number of years, although the initial increase is generally much greater than that found later.

3. *Changes in the Skin.* These are most remarkable. They consist in better capillary circulation, increase in sub-cutaneous tissue, greater moisture and softness, greater elasticity and improved colour. There is obliteration of wrinkles, flattening of furrows, removal of pigmentations and freckles. Often the contour of the face is altered beyond recognition. The general expression invariably improves to such an extent as to give a younger appearance. With the increased power of resistance and regeneration in the skin, chronic skin diseases such as eczema, psoriasis, pruritus, etc., disappear.

4. *Growth of Hair.* Changes in the growth of hair over the head, face and body are

constant. Bald patches get covered with new growth. The newly grown hair is invariably pigmented, which gives a younger appearance.

5. *Increased Tone of Muscles.* Another constant result is seen in the increased tone of muscles, both voluntary and involuntary. This is confirmed by testing muscular power of the body muscles by instruments such as dynamo-meter, and by the fact that the gastro-intestinal tract shows increased peristalsis and better function. The tone of the heart muscles as well as muscles in the coats of the arteries, the bronchi, and the bronchioles is improved, as shown by examination of these organs.

6. *Lowering of Blood Pressure.* In cardiac hypertrophy, in hypertonia and arteriosclerosis, high blood pressure is reduced in a fair percentage of cases. Although there is some lowering of blood pressure in almost every case, in many the improvement does not persist. This is confirmed by repeated examinations by mercurial manometer. This lowering is probably effected by relaxation of the muscles in the arterial coats and the

capillaries, through better tone of the sympathetic nervous system, and by means of cell regeneration and absorption of fibrous tissues causing thickening of the arterial wall. As the result of the lowering of blood pressure, marked clinical changes are noticed, such as regularity and lowering in the pulse beat, improved respiration on exertion, disappearance of insomnia, loss of pulsations and noises in the head, improved power of locomotion and exertion, and disappearance of abnormal skin sensations. There is also stoppage of epistaxis. Lichtenstern and Peter Schmidt have reported many cases of marked improvements in the circulatory symptoms in their case notes. In my own experience, improvement in this regard was found in 9478 per cent. of cases.

7. *Stenocardia.* Anginous pains, difficulty in breathing, rapid and irregular pulse and many other symptoms associated with this condition improve considerably though not, unfortunately, permanently in a fair percentage of cases. Lichtenstern, Peter Schmidt and many others have noted improvements in this condi-

tion. In my own cases, 83·34 per cent. of patients received relief in these symptoms, lasting from a few weeks to over four years.

8. *Improvement in Mental Condition.* Clinical reports abound in showing clear and obvious improvement in mental capacity after operations for regeneration. It is unnecessary here to give details of all the improvements noted, but interest and pleasure in work, freedom from fatigue or exhaustion even after prolonged and arduous physical and mental strain, speak clearly enough. Marked improvement in tissue nutrition and tissue metabolism, as shown in better functioning of the brain, is demonstrated by the quality and quantity of the patient's work and his brighter outlook on life, and a great sense of joy. Change in the patient's psychology is shown by a marked alteration in character. Timidity is replaced by courage, and even pugnacity ; shyness is replaced by sociability and suspicion is replaced by trust and confidence.

9. *Nervous Diseases. Tremor Senilis and Paralysis Agitans* receive strikingly favourable results. There is a variation

in the degree of improvement regarding tremor; in the most favourable cases I have noticed disappearance for over four years. In my series of cases, the percentage of success was 75.

Psychoses and Psycho-neuroses are, however, not so favourably affected as the condition mentioned previously. It is my considered opinion that cases of psychosis and psycho-neurosis resulting from deficiency in sexual hormones receive complete relief by reactivation operations, but those dependent on mental conditions get but partial or no relief. In the cases which came under my treatment, success was obtained in 52.64 and failures in 47.36 per cent. Sand[1] and Klika[2] have clinical data confirming the above observations.

10. *Improvement in Vision* has been reported by Sakaki, Schmidt and other observers. I have not noted it in my own series of cases.

11. *Improvement in Hearing.* This has been

1. Sand. *Vasligatur (Epididymectomi) anvendt ad mod Steinach i restitutionsjemed ved senium od andre tilstande (impotens, depression). Ugeskift for Laeger, Nr. 22-23, 1922.*
2. M. Klika. (Klinik Kostlivy), *Bratislauski Lekarskelisty. Feb., 1922.*

described by Benjamin and Heimann. I have not specially looked for it in my cases. This improvement is, however, perfectly understandable, as softening and absorption of inflammatory tissue, taking place as the result of improved tissue nutrition and tissue metabolism, would remove regional sclerosis and thus cause improvement in hearing.

12. *Improvement in Voice.* Although functional changes do occur in the larynx through increased output of sexual hormone, improvement in the quality and volume of voice is not obvious except in cases where the voice was markedly thin, piping, or weak before the regeneration operation, *e.g.*, in cases of eunuchoids, early castrates and patients with very marked senility. Even ordinarily the quality and timbre of the voice is improved. Schmidt, Hofbauer[1] and Sakaki[2] give cases treated by them in which this improvement was noted.

13. *Impotence.* An increase or return of

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1. Hofbauer. *Biologie der Schwangerschaft.*, *Aerztl. Verein*, Muenchen, 9 Mai, 1921.

2. Sakaki. *Mitteilungen an den japanischen National. Aerztl. Congress, April 1923.*

sexual potency is a marked feature of the results of these operations. This feature has, unfortunately, been unduly stressed. Indeed, the word rejuvenation, used by Steinach in connection with his experiments, raised a great deal of prejudice and opposition against his epoch-making discovery. Although improvement in potency is a prominent and marked feature, it is by no means the only, or even the most important, result of the operations for regeneration. Impotence, however, is materially improved by these methods, and evidence in support of this contention has accumulated from reports of cases treated by a host of workers. In my own series of cases, I got successes in 89·48 and failures in 10·52 per cent. Benefits in this direction vary from slight, though marked, improvements to pronounced and lasting effects. There is not only an increase in sexual desire but also a greater ability to perform the sexual act. The erotisation of the nervous system by the newly produced hormone causes profound change in physico-sexual and psycho-sexual character.

14. *Changes in the Genital Organs.* It must

be mentioned that apparent growth of the penis occurred in many cases. Whether it was occasioned by an improved tone of the blood vessels, or whether the change was a real growth as a direct result of the output of hormone, is doubtful.

15. *Results in Testicular Defects.*

Anorchidia. In cases of anorchidia due to congenital defect or resulting from surgical excision of testes, implantation of testicles has proved very helpful, specially in cases of bi-lateral deficiency, as Steinach's operation could not be resorted to in these cases. Even in uni-lateral anorchidia, one hesitates to perform vaso-ligation and vasectomy, for thereby complete sterilisation would follow. Testicular implantation, therefore, is the best remedy both in uni- and bi-lateral anorchidia. In my series of cases, successes were obtained in 54.55 and failures in 45.45 per cent.

Atrophy. In cases of atrophy due to crypt-orchism, or following accidents, or due to inflammation caused by mumps, gonorrhœa, syphilis or pyogenic infections, better results have been obtained than in cases of anorchidia. A notable

feature, not recorded to my knowledge by any other worker, has been noticed in my cases, namely, distinct softening and absorption of inflammatory thickening and induration, with obvious regeneration of the testicular glands together with potency of the seminal ducts, producing both potency and fertility. In my series of cases, 75 58 per cent. of successes and 24 42 per cent. of failures are recorded.

16. *Prostate.* The effect of vaso-ligation and vasectomy on the prostate gland needs fuller discussion. Innumerable clinical findings show undoubted improvements in prostatics. Lichtenstern emphasises favourable results on micturition and general condition in patients in whom enucleation of the gland was refused or could not be performed, but in whom Steinach's operation was resorted to. Haberer[1], confirms Lichtenstern's results. Chetwood[2] has practised vaso-ligation over a considerable number of years on prostatics with lasting good results.

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1. Haberer. *Vasektomie bei Prostatahypertrophie. Med. Klinik, 1921, No. 14.*
2. C. H. Chetwood. *Vaso-ligation and Steinach's Investigations. Address before the Medical Society of New York, April 1922.*

Landau[1] was able to avoid enucleation of the prostate by practising vaso-ligation, after which patients appeared and felt much improved.

Objections Answered.

There are three varieties of cases generally seen. *First,* inflammatory hardening along with hypertrophy of the prostate glands; *second,* simple adenomatous hypertrophy; and *third,* very rare, cases of simple chronic inflammatory thickening. The cases of malignant growth of the prostate or of tubercular infection of the gland are not benefited by vaso-ligation. In view of Steinach's results in senile rats, producing enlargement of the prostate after vaso-ligation, many clinicians have objected to vaso-ligation in prostatics, fearing that it might lead to growth of the prostate gland. But it is not right to draw analogy between the results of Steinach's experiments on rats, where the prostate and seminal glands play quite a different and more essential part even as secondary sex character than they do in

1. Landau. *Ueber die Vasektomie als Behandlungsmethode der Prostatahypertrophie. Klin. Wochenschr., 1923, No. 6.*

men suffering from diseased and enlarged prostate. The biologist works with organs that are normal and not diseased and which play a different role from that of man. The clinician has to deal with diseased and hypertrophied prostate, which even in normal condition plays a different role in man from that of the prostate in rats. But the satisfactory clinical results of vaso-ligation in prostatics are the best refutation of those objections.

Various explanations are given for these favourable clinical results. One is "disuse atrophy", *i.e.*, after vaso-ligation, as no semen comes through, the prostate does not require to produce as much secretion as before to form the vehicle for the seminal fluid. The other explanation is that ligation injures secretory nerves to the prostate. To my mind, the real explanation consists in the improvement in tissue nutrition and tissue metabolism causing softening and absorption of fibrous tissue, and leaving the glandular tissue alone, which is soft and elastic and does not press or clasp forcibly the urethra and does not, therefore,

produce symptoms of vesical obstruction. In my cases of prostatic hypertrophy, the successes obtained were 81·25 and failures 18·75 per cent. In cases of chronic inflammatory thickening, the results were 80 per cent. successes and 20 per cent. failures.

17. *Improvement in Physiological and Premature Senility.* In the normal life of man, we notice the beginning of climacterium at about the age of 50, although not with the same regularity as in women. After this age, both physical and psycho-sexual involution sets in. But exceptions to the above normal are not very uncommon. We find men in the prime of life with well-marked secondary sexual characters in whom sexual desire and potency are weak or have been lost or have never been present. We find also, on the other hand, fairly old men with advanced physical and mental disintegration but with complete potentia coeundi and generandi. There is also the prodigal son who has indulged himself in his youth to an extent that before he reaches early middle age he is senile.

The study of case-notes of a large

number of clinicians has shown that the results obtained by regeneration operations have been consistently good though variable. These patients suffer from a large number of varying disabilities and symptoms of senescence. The improvements indicated under the different heads are found to a greater or less extent in these patients. The sum total of the improvements is generally most satisfactory and, in many cases, quite startling. In my own series I have obtained 68·75 per cent. of successes and 31·25 per cent. of failures in cases of physiological senility, *i.e.*, patients between 65 and 95 years; whereas in cases of premature senility, *i.e.*, between 35 and 65 years, the results obtained were 87·64 per cent. of successes and 12·35 per cent. of failures.

Nearly fifty years ago, Brown-Sequard, referring to the limits of regeneration, wrote—"One can only rejuvenate tissues which are still rejuvenable." A great deal of advance has been made in the interval and to-day we can do more than Brown-Sequard thought possible, but we reach an impassable boundary where we have to do with irreparably damaged tissues. This leads us to the consideration of indications

and prognosis. In what cases are we to try to regenerate, and what are the prospects of good results ?

Indications for Regeneration.

The two main indications for regeneration are—*first,* the commencement of the decline of the vital forces with which senility begins at the close of the period of maturity ; and *secondly,* the imperfect development of maturity as in infantilism and eunuchoidism. Obviously there can be no object in inaugurating the Steinach impulse during the period of full maturity, nor can there be any advantage in pursuing regenerative methods in the later phases of senile decay when irreparable changes in structure have already issued. The onset and intensity of senility, however, vary much from individual to individual. We sometimes see marked senile changes in persons who are not yet forty ; on the other hand, we come across persons in the seventh and eighth decade of life who are active, hale and hearty. But in the great majority of cases of both men and women, specially of women, we must regard the age of fifty as the turning point between maturity and senility. The best period for regeneration both in men and women is at about fifty, which may be regarded as that of

climacterium—in women definitely, in men probably—when the first carency symptoms due to the decline in the function of the sex-gland make their appearance. Often, however, the climacterium begins much earlier. In my case-notes are found not a few patients in the thirties and forties who needed regeneration urgently. I have sometimes been consulted, on the other hand, by patients in the sixties whose general appearance and physique were so youthful that I was reluctant to interfere.

Criteria of Advancing Senility.

The important criteria of advancing senility, in my experience, are loss of elasticity in the skin, the condition of the sex-glands, and rise in blood pressure in persons even though they are still young in years. A rise in blood pressure, to begin with, is nothing more than a symptom of functional changes in the arterial wall, but after it has continued for years it leads to irreparable structural changes in the blood vessels. When the arterial walls have become hard due to deposit of inelastic and insoluble substances, regenerative methods come too late. In my opinion, therefore, rise in blood pressure should be considered as an urgent indication for inducing Steinach effect. Even more important and urgent, per-

haps, are the onset of arcus senilis, senile cataract and the appearance of the train of symptoms resulting from senile enlargement or atrophy of the prostate. The same remarks apply to the cases of typical climacteric depression in both sexes. The regenerative method can do no harm. It aims at removing the cause instead of treating the results.

Contra-Indications.

The chief contra-indications for regenerative methods are :—(1) Valvular disease of the heart with defective compensation, (2) other grave organic diseases, (3) malignant growths, (4) tuberculosis, (5) infective fevers, and (6) sexual neurasthenia of psychic origin.

Prognosis.

After a close reading of the available literature on the subject and a careful study of my own cases, the following prognosis may be given :—(1) No bad effects are produced by Steinach's operation. (2) When it is applicable and successful, it gives the best results, better than any other regenerative method ; but it is not universally successful. It is the easiest of all regenerative methods and utilises one's own sex-glands for reactivation. (3) In successful cases, it reduces blood pressure, increases muscular power, both of striped and non-striped

muscles, increases appetite, removes indigestion and constipation, improves circulation and nutrition of the skin and hair, improves temper, memory and mental capacity and increases sexual desire, potency and pleasure. (4) Grafting of testes has no ill effects ; it is a more delicate, difficult and costly operation than vasoligature and vasectomy, but more generally applicable. (5) Human testes give best results ; next, those of apes. Those of lower mammals require several grafts. (6) X-radiation, diathermy, albugineotomy and carbolisation of the cord give indifferent results. (7) Grafting of ovaries from human subjects give best results ; ovaries of apes, sheep, and goats have proved useful. (8) X-radiation and diathermy of ovaries have given very good results.

CHAPTER XII

CONCLUSIONS AND LINE OF FUTURE WORK

In the previous chapter a comprehensive summary has been given of clinical results obtained by the writer for the various conditions in which regenerative methods were practised. These clinical results also indicate the line of further extension of these therapeutic measures in the field of endocrine diseases.

Effect of Hormones on Capillary Circulation.

Fortunately, the extensive researches of numerous endocrinologists have now advanced our knowledge in this branch of medicine to such an extent that insufficiency and disfunction in one or more of the incretory glands can be discovered, tested and made certain. Not only this but the deficiency can be measured both in a qualitative and a roughly quantitative manner. Professor Otfried Mueller[1], of the University of Tuebin-

1. Otfried Mueller, Chief of Medical Clinic in Tuebingen, and his work as given by Karl A. Bock in *Das Peripherische Gefasssystem und seine Beeinflussung durch Organpraeparate.* Exper. Medizin. Bd. LV Heft 3/4. Julius Springer, Berlin, 1927.

gen has been experimenting on the circulation in capillaries in various parts of the human body. He has studied the effects of various chemicals and hormones on these capillaries and has prepared a comprehensive map giving micro-photographs of the capillaries in normal condition, in diseased conditions, and after injections of various chemicals and hormones. He has found specific results following injections of hormones when any one or more internal secretory glands are in a normal or abnormal condition, whether in a state of hypo- or hyper-secretion. He can thus find with precision whether a certain hormone is secreted in a normal or abnormal quantity, *i.e.*, in increased or diminished quantity. He has prepared an atlas with charts showing the appearances of the capillaries in varying conditions. His method has been tested and found reliable as a qualitative test in cases of disfunction of the endocrine gland.

Professor Paul Hirsch[1] of Jena has devised an interferometric method of testing the different hormones. The blood serum to be examined is kept in an incubator together with standardised

1. Paul Hirsch. *The Abderhalden Reaction, by means of the Quantitative Interferometric Method. The Klinische Wochenschrift, 4th year, Nos. 28 and 29.* Julius Springer, Berlin.

powdered substance of the gland whose hormone it is desired to test. The protective ferments present in the blood bring about disintegration of the powdered substance, which by itself is insoluble in the serum. The peptone which is thereby formed, *i.e.*, the decomposition product, causes concentration of the incubated serum to rise, and this can be estimated interferometrically.

Interferometric Method of Testing Hormones.

The results obtained by this method are compared with the normal curve prepared as the result of researches by Zimmer, Leudel, and Ichlow. In the normal curve, the decomposition values of the most important internal secretory glands in healthy subjects as obtained by the interferometric tests have been laid down. By comparison of the results obtained in the given serum of the patient with the normal figures, disturbances,—deficiency or increase,—in the internal secretory system are discovered and a roughly comparative quantitative chart can be drawn up.

The field of practical utility of these methods lies mainly in the precise etiological diagnosis of the different internal secretory diseases. This method, together with other

Treatment of Diabetes by Regenerative Methods.

trustworthy clinical methods, provides us with valuable indications for introducing rational organotherapy. Diabetes, for instance, is now fully recognised to be caused by deficiency of secretion in the islands of Langerhans in the pancreas and insulin treatment is now the well-established remedy. The effects of these injections are but evanescent and temporary. A more lasting method of treatment should be devised. A case of diabetes from Steinach's collection may be mentioned, where sugar excretion was absent for fifteen months after Steinach's operation without any restrictions in diet. It would be worth while to examine the whole problem of the treatment of diabetes from the new angle by grafting the pancreas or ligaturing a few branches of the duct of pancreas together with Steinach's operation in order to reactivate the entire hormono-poitic system. Not only insufficiency in the secretion of one gland, but many glands, singly and collectively, should be re-examined and treated afresh.

We must make use of our experimental and clinical experience regarding the relationship between the sex-gland and other internal secretory glands and the somatic and psycho-sexual constitution of the individual. Our clinical effort will be fruitless unless we grasp the whole

complex of ideas as to the line of future progress. Steinach half jestingly said, "I think the day will come when vaso-ligature, or some other process having a like effect, will be undertaken by the State for every man of 50, just as every child is vaccinated for the prevention of smallpox to-day." In view of the advances in the natural sciences within the last fifty years, and in view of the resulting changes in our habits and ways of life, there does not seem to be anything extravagant in the foregoing prophecy. There is nothing extravagant or strange in the idea of a universal campaign against the disability of old age.

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